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Revised Phase III RCRA Facility Investigation (RFI) Report – HELSTF Sites – Second Revision (August, 2010)

White Sands Missile Range, New Mexico

~~July~~August 2010

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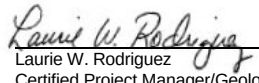

Laurie W. Rodriguez
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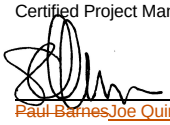

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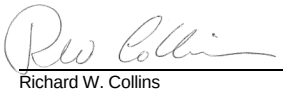

Richard W. Collins
Project Director

Revised Phase III RCRA Facility Investigation (RFI) Report – HELSTF Sites – Second Revision (August, 2010)

White Sands Missile Range
New Mexico

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GP08WSMR.HSTF.DP001

Date:
13~~6~~ August ~~June~~ 2010~~September 2009~~

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Appendices

1. List of Acronyms

A comprehensive list of acronyms used throughout this report is provided below:

1,1-DCA	1,1-Dichloroethane
1,1-DCE	1,1-Dichloroethene
1,1,1-TCA	1,1,1-Trichloroethane
1,2,4-TMB	1,2,4-Trimethylbenzene
1,3,5-TMB	1,3,5-Trimethylbenzene
AOC	Area of Concern
ASI	Advanced Sciences, Inc.
AST	Aboveground Storage Tank
ATSDR	Agency for Toxic Substances and Disease Registry
BAF	Bioaccumulation Factor
BCF	Bioconcentration Factor
BEHP	Bis(2-ethylhexyl)phthalate
BERA	Baseline ERA
BSL	Background Screening Level
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
$CaCO_3$	Calcium Carbonate
$CaSO_4$	Calcium Sulfate
CC	[the Army] Compliance Cleanup Program
CCWS	Compliance Cleanup Program White Sands Missile Range
CERCLA	Comprehensive Environmental Response, Compensation & Liability Act
cfm	Cubic Foot Per Minute
CFW	Cleaning Facility Well
Cl/SO_4	Chloride/Sulfate
CMS	Corrective Measures Study
COPC	Constituent of Potential Concern
COPEC	Constituent of Potential Ecological Concern
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
DAF	Dilution Attenuation Factor
DF	Deuterium Fluoride

DoD	Department of Defense
DP	Discharge Plan
DRMO	Defense Reutilization and Marketing Office
DRO	Diesel Range Organics
DRW	Diesel Recovery Well
ELCR	Excess Lifetime Cancer Risk
EPA	Environmental Protection Agency
EPASSL	Environmental Protection Agency Soil Screening Level
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESL	Ecological Screening Level
FOC	Fraction of Organic Carbon [percent]
FOD	Frequency of Detection
ft amsl	Feet Above Mean Sea Level
ft bgs	Feet Below Ground Surface
ft	Foot, Feet
ft/day	Feet Per Day
ft^2/day	Square Feet Per Day
FY	Fiscal Year
gpm	Gallons Per Minute
GPR	Ground Penetrating Radar
GRO	Gasoline Range Organics
HBG	Health-based Goal
HCF	HELSTF Cleaning Facility
HEAST	Health Effects Assessment Summary Tables
HELSTF	High Energy Laser Systems Test Facility
HHRA	Human Health Risk Assessment
HF	Hydrogen Fluoride
HI	Hazard Index
HMW	HELSTF Monitoring Well
HQ	Hazard Quotient
HSWA	Hazardous and Solid Waste Amendments of 1984
HTTS	HELSTF Tank Treatment System
HWB	Hazardous Waste Bureau

ID	Inside Diameter
IEUBK	Integrated Exposure Uptake Biokinetic Model for Lead in Children
IRIS	Integrated Risk Information System
IRM	Interim Remedial Measures
IRP	Installation Restoration Program
ISGR	In-situ gaseous reduction
ITC	International Technology Corporation
ITDP	Innovative Technology Demonstration Project
km^2	Square Kilometer
LESC	Lockheed Engineering & Sciences Company
LMW	Low molecular weight
LNAPL	Light Non-Aqueous Phase Liquid
LOAEL	Lowest Observed Adverse Effect Level
LPCL	Lower Power Chemical Laser
LSTC	Laser Systems Test Center
MAR	Multifunction Array Radar
MCL	Maximum Contaminant Level
MEK	Methyl ethyl ketone
mg/kg	Milligrams Per Kilogram
mg/kg-BW-day	Milligrams Per Kilogram Body Weight per Day
mg/L	Milligrams Per Liter
MTBE	Methyl Tertiary Butyl Ether
$NaNO_3$	Sodium Nitrate
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NAVFAC	Naval Facilities Engineering Command
NCEA	National Center for Environmental Assessment
NFA	No Further Action
NFRAP	No Further Remedial Action Planned
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NM GWQCS	New Mexico Groundwater Quality Control Standard
NMSSL	New Mexico Soil Screening Level
NOAEL	No Observed Adverse Effect Level

NOD	Notice of Decision
NOV	Notice of Violation
NPL	National Priorities List
OSWER	Office of Solid Waste and Emergency Response
PA	Preliminary Assessment
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
ppm	Parts per Million
PPRTV	Provisional Peer Reviewed Toxicity Values
PRS	Pressure Recovery System
PVC	Polyvinyl Chloride
RAP	Response Action Plan
RCRA	Resource Conservation & Recovery Act of 1976
Redox	Oxidation-reduction potential
RFA	RCRA Facility Assessment
RfD	Reference Dose
RFI	RCRA Facility Investigation
RTRP	Reinforced Thermosetting Resin Pipe
SAP	Sampling and Analysis Plan
SB	Soil Boring
SEI	Sverdrup Environmental, Inc.
SL	Screening Level
SLERA	Screening Level Ecological Risk Assessment
SMDC	[U.S. Army] Space and Missile Defense Command
SMDP	Scientific Management Decision Point
SNL	Sandia National Laboratories
SOP	Standard Operating Procedure
SSL	Soil Screening Level
SVOC	Semivolatile Organic Compound
SVS	Soil Vapor Survey
SWMU	Solid Waste Management Unit
TC	Toxicity Characteristic
TCA	Test Cell Area

TCE	Trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
THEL	Tactical High Energy Laser
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
Trace	Trace Analysis, Inc.
TRV	Toxicity Reference Value
TSA	Technical Support Area
UCL	Upper Confidence Limit
µg/dL	Micrograms per deciliter
µg/kg	Micrograms Per Kilogram
µg/L	Micrograms Per Liter
U.S.	United States
USACE	U.S. Army Corps of Engineers
USAEHA	U.S. Army Environmental Hygiene Agency
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UST	Underground Storage Tank
UTL	Upper Tolerance Limit
VOC	Volatile Organic Compound
VRP	Voluntary Remediation Program
WQCC	Water Quality Control Commission
WSMR	White Sands Missile Range
WSTF	White Sands Test Facility
WTS	White Sands Technical Services, LLC

2. Executive Summary

This document is the Revised Phase III Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report for the High Energy Laser System Test Facility (HELSTF) Second Revision (August, 2010) at the White Sands Missile Range (WSMR), White Sands, New Mexico (Figure 2-1). The original Phase III RFI Report for the HELSTF sites (White Sands Technical Services [WTS], 2008) was submitted to the New Mexico Environment Department (NMED) in February 2008. ~~This~~ In response to NMED's letter dated August 27, 2008, Notice of Disapproval Phase III RCRA Facility Investigation (RFI) Report HELSTF Sites, ~~. A~~a revised Phase III RFI Report was prepared and submitted to the NMED during September 2009. ~~in response to NMED's letter dated August 27, 2008, Notice of Disapproval Phase III RCRA Facility Investigation (RFI) Report HELSTF Sites and~~ The Revised RFI Report addresse~~s~~d NMED's comments contained in that letter. A summary of responses to NMED comments ~~is~~ is provided in this report in Table ES-1 immediately following this Executive Summary.

Following the submittal of the Revised Phase III RFI Report, NMED conducted a preliminary review of the document and provided ~~preliminary~~ comment to the Revised RFI Report in a letter dated March 11, 2010, Notice of Disapproval Phase II RCRA Facility Investigation (RFI) Report HELSTF Sites. This current report consists of a second revision to the Phase III RFI report, and a summary of responses to the NMED's preliminary comments is provided in Table ES-2, which ~~that~~ also follows this Executive Summary.

Overview

~~T~~This report presents current and historical data collected at the sites, including data from the Phase I, II, and III RFIs that were previously conducted at the HELSTF. The Solid Waste Management Units (SWMUs) addressed under the Phase III RFI include:

- SWMUs 23 and 24 – Hazardous Waste Tanks at HELSTF;
- SWMU 25 – Waste Accumulation Area;
- SWMU 26 – Vapor Recovery Unit at HELSTF;
- SWMU 27 ~~through 30~~ – Sanitary Treatment ~~System~~ Impoundment at HELSTF (CCWS-79; WSMR-44);
- SWMUs 31 and 32 – Chemical Waste Tanks (WSMR-43);

- SWMUs 33 and 34 – Fluorspar Tanks (WSMR-49);
- SWMUs 35 and 36 – Ethylene Glycol Tanks at HELSTF (WSMR-50);
- SWMU 37 – Waste Oil Accumulation Area at Building 26121 at HELSTF;
- SWMUs 38 and 39 – ~~Construction~~ HELSTF Landfills (CCWS-75; WSMR-52);
- SWMU 141 – Equipment Storage Area (WSMR-83);
- SWMU 142 – HELSTF Cleaning Facility Sump (CCWS-05; formerly WSMR-48);
- SWMU 143 – HELSTF Storage Yard ~~Chromate~~ Chromium Spill Site (WSMR-54);
- SWMU 144 – HELSTF Laser Systems Test Center (LSTC) Wastewater Discharge ~~Point~~ Pond (CCWS-02; WSMR-47);
- SWMU 145 – HELSTF Test Cell Lagoons (WSMR-53);
- SWMU 146 – ~~Dry~~ HELSTF ~~Sanitary Treatment Pond (~~STP~~)~~ Dry Pond (CCWS-03; WSMR-45);
- SWMU 147 – Decontamination Pad ~~and~~ & Underground ~~Storage~~ Holding Tank ~~(UST)~~ (WSMR-78);
- SWMU 148 – Former Multifunction Array Radar (MAR) Waste Stabilization Pond (WSMR-83);
- SWMUs 149, 151, and 152 – ~~Septic Systems~~Maintenance Building Septic System, Trailer Area Septic System, Property and Supply Building Septic System (Septic Systems - WSMR-46);
- SWMU 150 – MAR Dump Site;
- SWMU 154 – HELSTF Systemic Diesel Spill Site (WSMR-55);
- Area of Concern (AOC) N – Process Spills at the HELSTF;
- AOC-Q – HELSTF Lab Drains; and
- AOC-V – HELSTF Pressure Recovery System (PRS).

The locations of these SWMUs within the HELSTF are shown on Figure ~~1~~2-2, and Table ~~1~~2-1 provides a summary of potential wastes managed at these SWMUs. The purpose of the Revised Phase III RFI Report, Second Revision (August, 2010) was to present a comprehensive evaluation of all previously collected RFI data to determine whether releases occurred from the SWMUs and to evaluate associated risks to determine the need for corrective action. The comprehensive evaluation included:

- Preparing a Revised Conceptual Site Model (CSM);
- Conducting a Background Characterization Study;
- Conducting a comprehensive data evaluation to characterize subsurface conditions at each of the SWMUs; and
- Conducting comprehensive Human Health and Ecological Risk Assessments.

CSM **Summary**

The revised CSM provides for a more current interpretation of conditions based upon additional evaluation of subsurface soil and groundwater ~~conditions~~data and technical information. As part of the CSM, a~~three-dimensional geological model to evaluate groundwater flow and migration to the Regional Aquifer was prepared using EVS visualization software (www.ctech.com/EVS) and is presented within this report (as .avi movie files). A~~ water balance analysis was performed to estimate the flux of water infiltrating the vadose zone (~~previously~~ historically referred to at the site as perched water) and to estimate the potential for recharge and corresponding contaminant migration to the Regional Aquifer. A stable isotopes and mixing analysis was conducted to ~~better~~ further characterize the infiltration ~~rate~~ and recharge ~~rate~~ from the vadose zone to the Regional Aquifer. Additionally, the revised CSM included a comprehensive geochemical evaluation to identify naturally occurring minerals that are associated with the geochemistry of subsurface sediments and water in the Tularosa Basin that extend beneath WSMR and the HELSTF. The revised CSM characterizes the environmental setting as follows:

- Groundwater recharge to the Tularosa Basin at the basin interior and near the site is negligible due to very low precipitation and high evapotranspiration rates.
- Water in the vadose zone is primarily the result of both historical discharges and ongoing leaks in the water distribution systems at the HELSTF. It is heterogeneously distributed both laterally and vertically. The water balance for the HELSTF provides an explanation for the currently stable or decreasing water levels

in the vadose zone. The net water flux is generally downward to the Regional Aquifer at a rate that is currently estimated at ~~2.1~~about 2 gallons per minute (gpm).

- The saturated portions of the vadose zone exhibit a complex localized pattern of limited connectivity that suggests that it is more appropriate to describe the vadose zone as a system with variable saturation rather than a system containing perched aquifers. The lack of lateral continuity in vadose zone water results in asymmetric transport and commingling of dissolved contaminants in such a way that specific source identification is often difficult, and in some cases undetermined.

- Due to the ~~highly~~ complex nature of flow paths in the vadose zone, the degree of connection observed between vadose zone water and groundwater in the Regional Aquifer varies with location across the HELSTF site and ultimately results in variable mass flux down to the Regional Aquifer.

- Natural geologic processes in the Tularosa Basin have resulted in the occurrence of soluble minerals that contain many inorganic compounds. Weathering of out-cropping rocks provides for the natural occurrence of metals (strontium, selenium, boron, fluoride, lithium, aluminum, barium, and vanadium) and other inorganic compounds (chloride, sulfate, and nitrate) for sediments accumulating in the basin. Scientific literature shows that simple dissolution of naturally occurring minerals causes many of these metals and inorganic compounds to exceed regulatory limits established for groundwater quality.

- Low oxidation-reduction potential (redox) conditions resulted from the biological degradation of organic material in the subsurface. Several naturally occurring elements at the HELSTF that include iron, manganese, arsenic, cobalt, copper, cadmium, antimony, and nickel become more soluble in water under low redox conditions when they are reduced to more soluble forms or the minerals that contain them become less stable.

The Background Characterization Study was conducted to evaluate site-specific metal concentrations in support of the comprehensive geochemical evaluation described above. These results confirmed that several constituents identified within subsurface soils beneath the HELSTF are naturally occurring. The results of this study, along with the comprehensive geochemical evaluation, were used to distinguish naturally occurring constituents from constituents that should be considered constituents of potential concern (COPCs) because they were released as wastes (not naturally occurring constituents) when evaluating the nature and extent of releases for the wastes managed at the SWMUs.

A comprehensive data evaluation was conducted to characterize the nature and extent of COPCs within subsurface soils and groundwater. As detailed in this report, soil and groundwater were evaluated using criteria established by the NMED and/or the EPA. Nature and extent determinations for soil were performed on a SWMU-by-SWMU basis. As explained by the CSM, groundwater pathways are more complex and required a site-wide approach for vadose zone and Regional Aquifer conditions. As part of this site-wide evaluation of groundwater, each COPC was evaluated with regard to its unique distribution in the vadose zone water and regional groundwater, and a conceptual model for the occurrence and distribution was used to identify its source and delineate its occurrence.

As discussed in detail within this report, evidence for data demonstrates that an off-site source(s) for trichloroethylene (TCE), 1,1-dichloroethene (1,1-DCE), and chromium in the Regional Aquifer has been identified upgradient of the HELSTF area. The detections of these concentrations in the Regional Aquifer may be attributed to the off-site upgradient source. The evidence for the off-site source(s) is provided in Appendix I of this report.

Risk Assessments

Risk assessments were conducted using data collected during the Phase I, Phase II, and Phase III RFI site investigations. The environmental data collected throughout the various phases of investigation were grouped by SWMU and medium of interest (e.g., soil and groundwater), and evaluated to produce risk assessment data sets. The risk assessments included Human Health Risk Assessments (HHRAs) and Ecological Risk Assessments (ERAs). Site-specific HHRAs were conducted at each SWMU to evaluate the current and future potential risks to human health associated with constituents detected in surface and subsurface soil samples and in the vadose zone water underlying each SWMU. Site-specific ERAs were conducted at each SWMU to evaluate the potential current risks to ecological receptors associated with constituents detected in shallow soil conditions (i.e., in the upper 10 feet) at the HELSTF sites.

An HHRA was conducted to evaluate potential risks associated with human exposure to COPCs in groundwater from the Regional Aquifer. A site-wide approach was used for the HHRA of the Regional Aquifer because the aquifer is continuous and exhibits similar exposure potential across the HELSTF site. ~~Therefore, a holistic approach to the evaluation of potential risks in the Regional Aquifer is more appropriate.~~ In addition, the complexity of the hydrogeologic setting makes a SWMU-by-SWMU evaluation of the Regional Aquifer impracticable at the HELSTF. Therefore, a holistic

approach to the evaluation of potential risks in the Regional Aquifer is more appropriate.

Based upon the RFI findings, the SWMUs have been grouped into one of three categories that include: SWMUs with no identified releases of COPCs; SWMUs with releases to soil only; and SWMUs with releases to both soil and groundwater.

SWMUs with no identified releases of COPCs include:

- SWMUs 23 and 24 – Hazardous Waste Tanks at HELSTF;
- SWMU 25 – Waste Accumulation Area;
- SWMU 26 – Vapor Recovery Unit at HELSTF;
- SWMU 27 – Sanitary Treatment Impoundment at HELSTF;
- SWMUs 31 and 32 – Chemical Waste Tanks;
- SWMUs 33 and 34 – Fluorspar Tanks;
- SWMUs 35 and 36 – Ethylene Glycol Tanks at HELSTF;
- SWMU 37 – Waste Oil Accumulation Area at Building 26121 at HELSTF;
- SWMU 145 – HELSTF Test Cell Lagoons ~~Area~~;
- SWMU 146 – HELSTF STP Dry Pond ~~HELSTF Stabilization Pond~~;
- SWMU 147 – Decontamination Pad and Underground Holding Tank; ~~UST;~~
- SWMUs 149,151, and 152 – Septic Systems and
- SWMU 150 – MAR Dump Site.

SWMUs with releases of COPCs to soil only include:

- ~~SWMUs 31 and 32 – Chemical Waste Tanks;~~
- SWMUs 38 and 39 – ~~Construction~~ HELSTF Landfills;
- SWMU 141 – Equipment Storage Area~~;~~; and

- SWMU 148 – Former MAR Waste Stabilization Pond.
- ~~SWMU 146 – Dry HELSTF STP Pond; and~~
- ~~SWMU 150 – MAR Dump Site.~~

The soil conditions at the SWMUs listed above have been delineated.

SWMUs with releases to both soil and water include:

- SWMU 142 – HELSTF Cleaning Facility Sump;
- SWMU 143 – HELSTF Storage Yard ~~Chromate~~ Chromium Spill Site;
- SWMU 144 – HELSTF LSTC Wastewater Discharge Pond; and
- ~~SWMU 144 – HELSTF LSTC Wastewater Discharge PointPond;~~
- ~~SWMU 148 – MAR Waste Stabilization Pond; and~~
- SWMU 154 – HELSTF Systemic Diesel Spill Site.

The soil conditions at the SWMUs listed above were delineated at or near the SWMU. Vadose zone water and regional groundwater were delineated on a site-wide basis.

~~The data used to evaluate SWMUs 27 through 30 (Sanitary Treatment System) do not indicate a release of hazardous constituents to soil. However, vVerification samples will bewere collected from beneath these this SWMUs during December 2009in order to evaluate the underlying conditions. Results of this investigation do not indicate detections of COPCs.~~

No site-specific investigations were conducted at AOC-N – Process Spills, AOC-Q – Laboratory Drains, and AOC-V – PRS. However, as further described within this report, there were no historical releases reported and historical operations posed very low risk for significant releases to have occurred. Furthermore, these AOCs were situated in very close proximity to other SWMUs that were investigated as part of the RFI. AOCs N and Q are listed on the current WSMR RCRA permit as units with corrective action complete without controls. Based on these conditions, no further action is recommended at the AOCs.

HHRA Results

The results of the HHRA included the following:

- With the exception of SWMU 142, there were no unacceptable human health risks associated with current or future direct exposure to affected soils at any of the SWMUs. The direct exposure for a future residential scenario was determined to be above an acceptable target risk benchmark. The risk driver for this scenario was arsenic. Wastes containing arsenic were not managed at this SWMU. Arsenic is a naturally occurring metal that is attributed to low redox conditions beneath the Cleaning Facility.

- With the exception of SWMUs 142 and 154, the HHRAs show that affected soils do not pose a risk for current or future vapor intrusion. The HHRAs show that there are no current vapor intrusion risks for site workers at SWMUs 142 and 154. Future Site Worker and Future Resident vapor intrusion risks were identified for SWMU 142. Future Resident vapor intrusion risks were identified for SWMU 154. Because of the very low frequency of detection and limited spatial extent for the risk driver COPCs, in combination with the unlikely potential for future exposure (i.e., unlikely that the site will be redeveloped in the future), the concerns are low and additional evaluation is not necessary.

- Dilution/Attenuation Factor (DAF) ~~1~~ exceedances in soils suggest the potential for cross-media contamination from soils to groundwater for some constituents. Based on the CSM and water balance, it is unlikely that constituents in soil that is currently dry could potentially migrate to groundwater in the future because evapotranspiration rates are sufficiently high to prevent infiltration of rainwater, and the infiltration from leaking water and sewer lines has decreased dramatically over time. However, as a conservative measure, a long-term monitoring plan will be developed to address the potential for soils to cause increased COPC concentrations in the Regional Aquifer.

Findings from the site-wide groundwater risk assessment indicated current risk to site workers and hypothetical future risk to adult and child residents associated with exposure to groundwater as a potable water source. The drivers for cancer risk identified by the HHRA are camphechlor and arsenic. The drivers for the non-cancer hazards identified by the HHRA are cobalt and lithium. Of these constituents, only arsenic occurs on a widespread basis in the regional groundwater. Camphechlor was only detected in one sample from the Regional Aquifer and its detection appears to have been a spurious detection, not associated with a release from any SWMU. Cobalt was only detected in 6 percent of the regional groundwater sample population and its distribution does not appear to be related to a release from any SWMU.

~~L~~lithium, and arsenic are naturally occurring minerals associated with redox conditions and their occurrence in the regional groundwater is not the direct result of a release from any SWMU.

The identified risks associated with exposure to the Regional Aquifer are hypothetical risks because the Regional Aquifer has poor quality with total dissolved solids (TDS) concentrations consistently well above 10,000 parts per million (ppm) throughout the HELSTF area. There are no plans to use the Regional Aquifer at the HELSTF as a potable water source. Furthermore, the affected groundwater is fully contained within the confines of WSMR, which obtains its water from regional water wells outside the interior of the basin.

ERA Results

The results of the ERA include the following:

- Results of the SWMU-specific Screening Level Ecological Risk Assessments (SLERAs) and Baseline Ecological Risk Assessments (BERAs) concluded that adverse effects are unlikely to occur for ecological receptors potentially exposed to constituents in soils under current or hypothetical future land use conditions.

Recommendations

Based upon the findings of the RFI and risk assessment, **no further action is proposed for the following SWMUs**:

- SWMUs 23 and 24 - Hazardous Waste Tanks at HELSTF;
- SWMU 25 – Waste Accumulation Area;
- SWMU 26 – Vapor Recovery Unit at HELSTF;
- SWMU 27 – Sanitary Treatment Impoundment at HELSTF;
- SWMUs 31 and 32 – Chemical Waste Tanks;
- SWMUs 33 and 34 – Fluorspar Tanks;
- SWMUs 35 and 36 – Ethylene Glycol Tanks at HELSTF;
- SWMU 37 – Waste Oil Accumulation Area at Building 26121 at HELSTF;

- SWMUs 38 and 39 – ~~Construction~~ HELSTF Landfills;
- SWMU 141 – Equipment Storage Area;
- ~~SWMU 144 – LSTC Wastewater Discharge Point;~~
- SWMU 145 – HELSTF Test Cell ~~4~~ Lagoon~~s Area~~;
- SWMU 146 – HELSTF STP Dry Pond;
- SWMU 147 – Decontamination Pad & Underground Holding Tank~~and UST~~;
- SWMU 148 – Former MAR Waste Stabilization Pond;
- SWMUs 149,151, and 152 – Septic Systems;
- SWMU 150 – MAR Dump Site;
- AOC-N – Process Spills at the HELSTF;
- AOC-Q – HELSTF Lab Drains; and
- AOC-V – HELSTF PRS.

It should be noted that AOCs N and Q are referenced under the current RCRA permit as units with "Corrective Complete without Controls".

Based upon results of the RFI and risk assessments, conditions identified at the following SWMUs will be addressed as part of a long-term groundwater monitoring program:

- SWMU 142 – HELSTF Cleaning Facility Sump;
- SWMU 143 – HELSTF Storage Yard Chromium ~~Chromate~~ Spill Site; ~~and~~
- SWMU 144 – LSTC Wastewater Discharge Pond~~int~~; and
- SWMU 154 – HELSTF Systemic Diesel Spill Site.

~~It should be noted that AOCs N and Q are referenced under the current RCRA permit as "Units with corrective complete". Any warranted additional actions for SWMUs 27~~

~~through 30 (Sanitary Treatment System) will be determined following the proposed verification soil sampling.~~This report includes the following appendices:

- Appendix A – Standard Operating Procedures;
- Appendix B – Field Logs;
- Appendix C – Supporting Information – Conceptual Site Model;
- Appendix D – Analytical Reports;
- Appendix E – Human Health Risk Assessment Report and Ecological Risk Report;
- Appendix F – Background Characterization Report;
- Appendix G – Site-Wide Soil Data Maps;
- Appendix H – Site-Wide Groundwater Data Maps; and
- Appendix I – Technical Memorandum – Evidence for an Off-Site Source of TCE, 1,1-DCE, and Total Chromium in the Regional Aquifer Under the HELSTF.

~~As discussed in detail within this report, evidence for data demonstrates that an off-site source(s) for trichloroethylene (TCE), 1,1-dichloroethene (1,1-DCE), and chromium in the Regional Aquifer has been identified upgradient of the HELSTF area. The detections of these concentrations in the Regional Aquifer may be attributed to the off-site upgradient source. The evidence for the off-site source(s) is provided in Appendix I of this report.~~

Table ES-1 – White Sands Missile Range Response to New Mexico Environment Department Comments			
Comment No.	**NMED Comments**	**WSMR Response**	**Section/Page Reference in Revised RFI Report**
1	Overall, the Phase III RFI Report was very difficult to follow and data were not presented in a functional manner. The Permittee must include in the revised Report a summary table of all data results (RFI Phases I-III) for each Solid Waste Management Unit (SWMU) or group of SWMUs that includes the detected constituents, range of detections, mean concentrations, locations (boring identification and depth) of highest detection, background reference values (where appropriate), and screening levels (where appropriate).	A revised Phase III RFI report has been prepared that includes tables for each SWMU or group of SWMUs summarizing the data from all phases of the RFI. The tables include range of detections, mean concentrations, boring identification and depth of highest detection, background reference values (where appropriate), and screening levels (where appropriate). The summary tables are introduced in Section 6 (RCRA Facility Investigation Discussion). Soil data are presented on a SWMU-by-SWMU basis with table numbers that correspond to the section addressing the applicable SWMU. Groundwater data are provided as Tables 6-21 and 6-22.	Section 6/ Pages 97 through 389 Tables 6-1 through 6-19 Appendix E
2	Section 1.1 of the Report states that the purpose of this Phase III RFI Report is "to present a comprehensive evaluation of previously known contaminant releases and their associated risks at the HELSTF." While it is not expected that a complete reiteration of the Phase I and Phase II investigations be provided in the Phase III RFI Report, a discussion of the results of the previous investigations is required. a. Generally, the Permittee must include in the revised Report a more detailed discussion of the data from previous investigations that were summarized in this Report. b. In order to streamline the selection of constituents of potential concern (COPCs), individual SWMUs were combined into zones. The maximum detected concentration from a specific zone was compared to the background data set. If the maximum detected concentration was less than background, the constituent was eliminated as a COPC for the entire zone. It does	The revised Phase III RFI includes a more detailed and comprehensive discussion of the previous investigation results. The report includes a comprehensive summary of the soil data from all phases of the RFI (Tables 6-1 through 6-19 and Due to the volume of data and the change in operations over time, data evaluations for vadose zone water and groundwater were limited to the period between 2004 and 2009. Detailed summaries of previous investigations and comprehensive evaluations of data collected during all phases of the RFI on a SWMU-specific basis are provided in Sections 6.2 through 6.25. The COPC selection process for site characterization is described in Section 6.1 (COPC Selection Process for Site Characterization).	Section 6/ Pages 97 through 389 Tables 6-1 through 6-19

Table ES-1 – White Sands Missile Range Response to New Mexico Environment Department Comments			
Comment No.	**NMED Comments**	**WSMR Response**	**Section/Page Reference in Revised RFI Report**
	not appear that any data other than that collected as part of the Phase III investigation were used in the determination of COPCs. In order to eliminate a constituent as a COPC, data from all investigations must be considered. The Permittee must discuss (in the revised Report) on a site-by-site case whether soil data from Phases I and II exist, and if so, include a comparison of the cumulative data set to background. In addition, NMED evaluates sites for corrective action complete status on an individual basis, not in combination with surrounding sites.		
3	In Section 3.6 (SWMU Groundwater Monitoring Program), the Permittee states that the HELSTF Wastewater Lagoons and associated monitoring wells are monitored as part of the non-Resource Conservation and Recovery Act (RCRA) wastewater monitoring program. The Permittee must identify in the revised Report both the non-RCRA program under which this groundwater monitoring is being performed and the lead agency/bureau managing the wastewater monitoring program.	WSMR is not monitoring groundwater under any non-RCRA New Mexico State regulatory program.	
4	The Permittee states that the Wastewater Lagoons (SWMUs 27-30) have been replaced and will be decommissioned once the new wastewater lagoons are brought on line. If the Permittee does not submit a Notice of Intent (NOI) to the NMED's Groundwater Quality Bureau and obtain a discharge permit (20.6.2.7 NMAC) for the new wastewater lagoons, then these units will be added to the RCRA permit as SWMUs. The Permittee must state in the revised Report their intent regarding the regulatory status of the new	The sewage is excluded from RCRA regulations per 40 Code of Federal Regulations 261.4(a) "Materials which are not solid wastes". The new sewage lagoons are designed, constructed, and utilized in a manner that substantially diminishes the toxicity of any waste contained within the sewer system.	

Table ES-1 – White Sands Missile Range Response to New Mexico Environment Department Comments			
Comment No.	**NMED Comments**	**WSMR Response**	**Section/Page Reference in Revised RFI Report**
	wastewater lagoons and provide supporting documentation that indicates that status of the units (e.g., NOI, discharge plan).		
5	In Section 4.1 (Determine an Appropriate Exposure Point Concentration [EPC]), the Permittee discusses the use of upper confidence levels of the mean (UCLs) as exposure point concentrations. However, it does not appear that UCLs were determined at any of the SWMUs evaluated in this report; rather, site maximum concentrations were applied. The Permittee must clarify in the revised Report how EPCs were derived, including a discussion on the use of maximum detected concentrations.	A Revised Risk Assessment has been prepared as part of the Revised Phase III RFI Report. The Revised Risk Assessment provides a comprehensive evaluation of all data collected as part of the RFI. An overview of the risk assessment is provided in Section 5.4 (Risk Assessment Methods) of the Revised RFI Report. The Revised Risk Assessment includes EPC determinations as summarized in Section 5.4.2.2.2 (Exposure Point Concentrations). The Revised Risk Assessment that provides the supporting information used to derive EPCs is presented as Appendix E.	Section 5.4/ Page 79 Section 5.4.2.2.2/ Page 84 Appendix E
6	In Section 4.1 (Identify Contaminations of Potential Concern [COPCs]), the Permittee indicates that only those COPCs for which a standard or screening level could be identified were retained as COPCs. However, all inorganic constituents detected above background levels and all organics should be retained as a COPC regardless of whether standards and/or screening levels are available. For those COPCs for which a reference for comparison is not available, a surrogate datum should be applied; if an appropriate surrogate toxicity datum is not available, potential exposure to the COPC should be addressed in an uncertainties section. The Permittee must revise the methodology for identification of COPCs accordingly in the revised Report. Identify in the revised Report any constituents that may have been eliminated from the assessments based upon the "lack of standards or screening levels."	A detailed description of the COPC selection process is included in the revised Phase III RFI report. Section 5.4.2.1 (Constituent Characterization) discusses the methods used to select COPCs for the Human Health Risk Assessment (HHRA). Supporting information used to select COPCs for the HHRA is provided under Appendix E. As described in the Phase III RFI report, all constituents were evaluated as a COPC regardless of whether standards and/or screening levels are available. The process followed to select COPCs used for site characterization is described in Section 6.1 (COPC Selection Process for Site Characterization). Table 6-1 (Summary of COPC Selection) is also provided with the revised RFI Report.	Section 5.4.2.1/ Page 81 Section 6.1/ Page 97 Appendix E Table 6-1

Table ES-1 – White Sands Missile Range Response to New Mexico Environment Department Comments			
Comment No.	**NMED Comments**	**WSMR Response**	**Section/Page Reference in Revised RFI Report**
7	The comments related to soil background (Section 4.2.1, Background Soil Concentrations) are as follows and must be included in the revised Report: • Background summary statistics are provided for background (Appendix D). In reviewing the background data files, a total of six samples were used to derive the background reference values. It is assumed that the six samples are those collected from sample locations SB1 through SB6 identified on Figure 4.3-2 of the report. However, the notation on the ProUCL output files does not clearly state which sampling locations/depths the data represent. For example, there are files noted as As 20.0, As 30.0, and As 40.0. Provide a summary table of all data used to derive the background data set. Clarify the notations used in ProUCL and provide a summary table of the resulting background reference values. • Appendix D also contains derivation of subsurface background reference values. The report does not address how subsurface is defined or from where these samples were collected. Review of the ProUCL output files indicates that approximately 30 samples were used to compile the datasets; the sample locations are not obvious from reviewing Figure 4-2. The Permittee must provide a discussion of what these subsurface samples represent, provide a figure showing the location of the sampling locations used to derive the background subsurface reference value, provide a summary table of the data used as input into ProUCL, and provide a summary table of the resulting subsurface background reference values.	A revised Background Study was conducted as part of the Revised Phase III RFI. The Background Characterization study is described in Section 4.4 (Background Study). The Background Characterization Report is provided as Appendix F.	Section 4.4/ Page 62 Appendix F

Table ES-1 – White Sands Missile Range Response to New Mexico Environment Department Comments			
Comment No.	**NMED Comments**	**WSMR Response**	**Section/Page Reference in Revised RFI Report**
	• The locations of the background samples are provided on Figure 4-2. However, the report does not provide any justification for the selection of the location of this area as being appropriate for collection of background samples. For example, the report should include a discussion of site history to justify that the background reference area has not been impacted by any activities at WSMR. In addition, a comparison of soil types from the background samples to soil types noted at HELSTF is typically conducted to verify that the background area has similar soil/geologic structure. Given that the location of the background location is in close proximity to HELSTF, it is reasonable to assume likeness of soil. However, the close proximity also leads to concern whether this area has been impacted by site activities. Provide justification for the selection of this area as being representative of non-impacted soil. • Only six sample locations were selected for derivation of background. While statistically six samples is sufficient to conduct a UCL calculation, six samples collected from such a close proximity to each other does not provide an understanding of natural background variation. Note that additional background samples may be warranted with future investigations in order to understand natural variations in reference soils at WSMR.		

Table ES-1 – White Sands Missile Range Response to New Mexico Environment Department Comments			
Comment No.	**NMED Comments**	**WSMR Response**	**Section/Page Reference in Revised RFI Report**
8	While Section 5 (Revised Conceptual Site Model [CSM]) provides a summary of the results of additional groundwater investigation, a CSM was not provided nor specifically addressed. Revise the Report to include a revised CSM for both human health and ecological receptors.	The revised CSM for both human health and ecological receptors is addressed as part of the Risk Assessment provided as Appendix E. Discussion on the revised CSM as it pertains to the environmental setting for the HELSTF is presented in Section 4.3 (Environmental Setting and Conceptual Site Model).	Appendix E Section 4.3/ Page 24
9	The Permittee states in Section 5.1 (Hydrogeologic Setting) that after the old wastewater lagoons are fully decommissioned, the expectation is that the perched zones beneath HELSTF will largely dissipate. The remaining contamination could become a source of leaching contaminants by infiltrating surface waters, further impacting the regional aquifer. The Permittee must address in the CMS its expectation for the fate of the remaining contamination (including free product) in the two perched zones when the water dissipates, how this may impact the regional aquifer, and proposed actions to mitigate the source.	The revised CSM provided in Section 4.3 (Environmental Setting and Conceptual Site Model) provides detailed discussion on the current interpretation of vadose zone water and groundwater conditions Historical water level measurements were evaluated to support this interpretation. ~~A three-dimension geological model to evaluate groundwater flow and migration to the Regional Aquifer was prepared using EVS visualization software and is presented in this report. . Additionally, as part of the CSM, a three-dimensional 4DIM model to evaluate groundwater flow and migration to the regional aquifer was prepared and is described in the section referenced above.~~ A water balance that is also discussed in Section 4.3 was performed to estimate the flux of water infiltrating the vadose zone (previously referred to as perched water) and to estimate the potential for recharge and corresponding contaminant migration to the regional aquifer. Additionally, a stable isotopes and mixing analyses was conducted to better characterize the infiltration rate and recharge rate from the vadose zone to the regional aquifer. The ~~4DIM Model, (as .avi movie files)~~water balance evaluation, and stable isotopes and mixing analyses are also provided as appendices to the revised RFI report. Long-term monitoring of the vadose zone water and regional aquifer conditions will be proposed.	Section 4.3/ Page 24 ~~Appendix C-1~~ Appendix C-1 Appendix C-2 Appendix C-3

Table ES-1 – White Sands Missile Range Response to New Mexico Environment Department Comments			
Comment No.	**NMED Comments**	**WSMR Response**	**Section/Page Reference in Revised RFI Report**
10	The Permittee calculated background values for inorganic constituents in the regional aquifer beneath HELSTF. This was neither proposed by the Permittee in the Phase III RFI Work Plan nor approved by NMED and, consequently, was conducted at risk. The Permittee's designated background wells, HMW 8 and HMW 61, have obviously been impacted by operations at HELSTF based on the Permittee's calculated background concentration of 82.5 mg/l for nitrate. Based on the composition of the sediments in the subsurface at HELSTF, nitrate values of this magnitude are greater than the anticipated background. The ground water background concentrations calculated by the Permittee for the regional aquifer are questionable and therefore cannot be utilized for comparison with analyte concentrations in other wells at HELSTF.	Regional Wells HMW-8 and HMW-61 were not used as background wells for site characterization purposes in the revised Phase III RFI report. As part of the revised CSM, a review of published literature that addresses the natural occurrence of inorganic compounds, which are not waste constituents in the regional aquifer, was conducted as part of geochemical evaluations. Additional discussion on the natural occurrence of inorganics that include nitrate is provided in Section 4.3.	Section 4.3/ Page 24
11	The Permittee must install a regional aquifer monitoring well down gradient of SWMU 145 for long term groundwater monitoring. The Permittee must also propose the collection of surface and subsurface soil samples from borings drilled beneath the base of SWMUs 27 through 30 after the sludge and liners are removed. Well locations, procedures for well drilling/installation and soil borings, and procedure for sample collection and analysis must be proposed in the work plan referenced above. NMED evaluates each SWMU for corrective action complete status individually; therefore, the Permittee must ensure that all SWMUs are supported by data collected at each SWMU. If there are any SWMUs where samples have not been collected and analyzed, then the Permittee must propose additional sampling in the work plan at these SWMUs if corrective action complete status is to be requested.	Well HMW-56 was installed in the regional aquifer during the Phase III RFI. Sampling results from this monitoring well are presented in the Revised Phase III RFI Report. A summary of historical ~~these~~ data are provided in ~~Table 2 of~~ Appendix D-~~2~~3. Select wells will be proposed for long-term monitoring at the HELSTF. Soil samples ~~will be~~were collected beneath the bases of (SWMUs 27 through 30 were combined as SWMU 27 under the December 2009 RCRA permit) during December 2009. The analytical results for this investigation are further described under Section 6.5 (SWMU 27 Sanitary Treatment Impoundment at HELSTF). NMED's comment regarding requirements for achieving corrective action complete status is noted.	~~Table 2 of~~ Appendix D-~~2~~3

Table ES-1 – White Sands Missile Range Response to New Mexico Environment Department Comments			
Comment No.	**NMED Comments**	**WSMR Response**	**Section/Page Reference in Revised RFI Report**
12	The Permittee states that additional sources of water recharge to the subsurface are suspected but not currently known. The Permittee must investigate or otherwise address potential additional sources of recharge to the perched zones at HELSTF (e.g., location, estimated rate of recharge, composition of recharge, estimated duration, affects on ground water flow direction, affects on remediation efforts) in the CMS.	See response to Comment 9.	Section 4.3/ Page 24 Appendix C-1 Appendix C-2 Appendix C-3
13	As part of the evaluation of constituents detected at HELSTF, a comparison of observed results was conducted with the New Mexico Soil Screening Levels (NMSSLs) for a residential scenario (dated 2006). In the event a NMSSL was not available, an Environmental Protection Agency's (EPA) Region 6 medium specific screening level (MSSL) was applied. Please note that NMED is currently in the process of updating their NMSSLs and will be making these revisions available on-line this year. In addition, a new database of Regional screening levels (SLs) was published in June 2008. These Regional SLs were drafted by Regions 3, 6, 9; the Regional SLs now supersede the Region 6 MSSLs (as well as the Region 3 and 9 screening criteria). The Regional SLs may be found at http://epaprgs.ornl.gov/chemicals/ index.shtml. One of the primary differences between the new Regional SLs and the former MSSLs and NMSSLs is a change in hierarchy of toxicity data. The Regional SLs do not include National Center for Environmental Assessment (NCEA) data, which are typically not peer-reviewed or publicly available data, as part of the toxicological hierarchy. The hierarchy applied in the Regional SLs will also be	The updated NMSSLs and the USEPA Regional SLs were used as the SLs to evaluate the Phase I, Phase II, and Phase III data for the purpose of selecting the COPCs that were carried through the site-specific HHRAs. Section 5.3 (Data Evaluations) lists the specific criteria used to screen soil and groundwater data. Section 5.4 (Risk Assessment Methods) and Appendix E provide details pertaining to COPCs selected as part of the Risk Assessment. As described in the response to Comment 6, the process followed to select COPCs used for site characterization is described in Section 6.1 (COPC Selection Process for Site Characterization). A summary of COPC selection is also provided in Table 6-1. Summaries of site characterizations completed on a SWMU-by-SWMU basis for soil using the required criteria are provided in Sections 6.2 through 6.21. Summaries of site characterizations completed for groundwater are provided in Section 6.25. Other supporting information including tables and figures, which are referenced in the site characterization summaries that list comparative criteria, are also provided with this revised Phase III RFI Report.	Section 5.3/ Page 73 Section 5.4/ Page 79 Section 6.1/ Page 97 Sections 6.2 through 6.21/ Pages 101 through 344 Section 6.25/ Page 351 Tables Figures ~~Appendix D-2~~ ~~Appendix D-3~~Appendix E

Table ES-1 – White Sands Missile Range Response to New Mexico Environment Department Comments			
Comment No.	**NMED Comments**	**WSMR Response**	**Section/Page Reference in Revised RFI Report**
	adopted by NMED and will be reflected in the updated NMSSLs. As part of the review of this Phase III RFI Report, reported data were compared to the revised (still in draft) NMSSLs as well as the new Regional SLs. With the exception of the following, there were no significant differences and the overall conclusion of the screening assessment from comparison of site concentrations to the updated/new SLs did not change. However, for all future evaluations, either the updated NMSSLs (once available) and/or the Regional SLs should be used in lieu of the 2006 NMSSLs and the Region 6 MSSLs. • Table 4-4 (Organic Compounds Detected in Diesel Spill Zone) Screening levels for 1-methylnaphthalene and 2-methylnaphthalene are listed as not established. The new Regional SLs include toxicological data for these compounds and these data will be included in the updated NMSSLs. For 1-methylnaphthlene a residential SL was established as 220 mg/kg (carcinogenic risk adjusted to the NMED target risk level of 1E-05) and for 2-methylnaphthalene 310 mg/kg (noncarcinogenic). It is noted that the maximum observed results in the diesel spill zone are below these SLs, and thus additional evaluation of 1-methylnaphthalene and 2-methylnaphthalene at this site is not warranted. • The NMSSL for ethylbenzene is under review; however, the maximum observed value at this site is less than the Regional SL of 57 mg/kg, (carcinogenic risk adjusted to the New Mexico target risk level of 1E-05), and thus the conclusion that additional evaluation for ethylbenzene is not required does not change.		Appendix E Summary Tables Appendix G Appendix H Table 6-1

Table ES-1 – White Sands Missile Range Response to New Mexico Environment Department Comments			
Comment No.	**NMED Comments**	**WSMR Response**	**Section/Page Reference in Revised RFI Report**
	• The residential NMSSL for fluorine is listed as 2.66E+04 mg/kg but the correct NMSSL datum is 2.66E+03. It is noted that the maximum observed value is still less than the corrected NMSSL, and thus the conclusion that additional evaluation for fluorine is not required does not change. • Section 4.2.3.2 (Central Storage Zone) The Permittee shows the residential NMSSL for hexavalent chromium as 210 mg/kg. The residential NMSSL for hexavalent chromium is 234 mg/kg.		
14	At several sites, the Screening Level Ecological Risk Assessment (SLERA) concluded that there were potentially complete exposure pathways and possible ecological impact. For these sites, the maximum detected concentration of various constituents was compared to ecological screening levels. For most sites, there was only one chemical of concern, and thus, this approach was acceptable. However, for other sites, such as SWMU 146, there were two COPCs: arsenic and chromium. When assessing ecological impact, cumulative risk must be considered. Overall risk is determined though the calculation of hazard quotients and then summing the individual quotients to determine the hazard index. The hazard index is then compared to the NMED target hazard level of 1.0 for ecological receptors. This process is conducted because it is possible for each COPC to be below a screening level, but the cumulative hazard be in excess of acceptable risk. For each SWMU where a more detailed analysis of COPCs to screening levels is conducted, the Permittee must provide the associated hazard quotients and, where multiple COPCs are present, provide the resulting hazard index. In addition,	The Ecological Risk Assessment (ERA) for each SWMU was conducted as part of the revised Phase III RFI. A summary of methodologies used as part of the ERA is provided in Section 5.4.3 (Ecological Risk Assessment [ERA] Methods and Procedures). Additionally, the ERA is included as part of the Risk Assessment presented as Appendix E. All supporting information associated with the ERA is also included in Appendix E. The data sets used during the ERA process included data from the Phase I, II, and/or III RFIs.	Section 5.4.3/ Page 87 Appendix E

Table ES-1 – White Sands Missile Range Response to New Mexico Environment Department Comments			
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	for each SWMU, the Permittee must discuss whether any other soil data were available from the Phase I and/or Phase II investigations and if these data were used in determining the maximum detected concentrations for the screening assessment. This information must be provided in the revised Report.		
15	Table 7-1 (Conclusions and Recommendations) show that SWMU 150 meets the criteria for corrective action complete status and that appropriate documentation will be prepared to support removing this site from further action. However, the conclusion of the ecological risk assessment was that additional analysis is needed to assess potential avian toxicity to lead in soil. Based upon this conclusion, the recommendation for SWMU 150 must be revised to include additional ecological assessment (potentially additional sampling) rather than a recommendation for corrective action complete status. Clarify the appropriate actions needed for SWMU 150 and change Table 7-1 accordingly in the revised Report.	The revised RFI Report includes the summary of the ERA conducted at SWMU 150. Conclusions and recommendations for SWMU 150 that are based on site characterization, HHRA, and ERA are provided in Section 6.20.8 (SWMU 150 – Conclusions and Recommendations).	Section 6.20.8/ Page 319
16	At several sites, organic constituents were detected in soil and groundwater. However, there is no discussion of risks associated with the vapor intrusion pathway. As noted in EPA's guidance, the use of soil gas data is preferable to bulk soil data for evaluating vapor intrusion (see Johnson and Ettinger http://www.epa.gov/oswer/riskassessment/airmodel/johnsonettinger.htm. If there is indication that vapor intrusion to any of the buildings or structures located above contaminated soil/groundwater is either occurring or potentially could occur in the future, evaluation of the vapor intrusion pathway will be required. As an example, the	The vapor intrusion pathway is addressed as part of the HHRA (Appendix E) for buildings or structures located above contaminated soil and/or groundwater containing volatile organic compounds. The site-specific risk assessments evaluated vapor intrusion potential that could occur under current and potential future conditions. The vapor intrusion pathway for SWMU 144 is discussed in Section 6.14.6.2 (SWMU 144 – Vapor Intrusion Scenarios).	Appendix E Section 6.14.6.2/ Page 242

Table ES-1 – White Sands Missile Range Response to New Mexico Environment Department Comments			
Comment No.	**NMED Comments**	**WSMR Response**	**Section/Page Reference in Revised RFI Report**
	Permittee indicates in Table 7-2 that monitoring is recommended for SWMU 144 and a no further action (NFA) petition will be prepared to change the status of SWMU 144. However, organics are present in subsurface soil to the lower perched water table. In order for SWMU 144 to qualify for Corrective Action Complete status, evaluation of the potential vapor intrusion is required. Note that an additional investigation, including the collection of soil gas data may be warranted at other SWMUs.		
17	Please note that subsequent to the drafting of this Report, Region V updated the toxicological review for chromium (April 2008).	Comment noted. An attempt to locate the updated toxicological review for chromium (April 2008) via an on-line internet search was undertaken. However, the referenced toxicological review was not located. ARCADIS requests NMED provide additional clarification regarding this information.	
18	In Appendix F, Attachment A (SLERA SWMUs 27-30), the assessment concludes that following evaporation of the water present in SWMUs 27-30, there will be no ecological contact with surface water or groundwater. However, the report does not address sediment/surface soil. The current approach is to allow the ponds to evaporate and then once the ponds are dry, corrective measures will be addressed. While not specifically addressed in either this appendix or the rest of the Phase III RFI Report, sediment samples were not collected (Figure 4-5 does not indicate any samples were collected in the vicinity of SWMUs 27-30) to assess potential ecological risk to receptors to pond sediment. The primary concern is potential ecological exposure to sediments and once the ponds are dry, to residual contamination in the surface soil of the former ponds. Based upon a review of data provided in the Phase II RFI Report, it	As noted in the response to Comment 11, additional characterization of conditions at SWMU ~~s~~ 27 ~~through 30 will be addressed.~~ was conducted during December 2009 and the results of this investigation are discussed under Section 6.5 (SWMU 27 – Sanitary Treatment Impoundment at HELSTF).	Section 6.5.8/ Page 143

Table ES-1 – White Sands Missile Range Response to New Mexico Environment Department Comments			
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	does not appear that characterization of SWMUs 27-30 has been adequately defined. The Permittee must propose in the work plan referenced above additional sampling to characterize surface soil at SWMUs 27-30 and re-evaluate ecological risks after complete evaporation of the residual water and removal of the sludge/liners but prior to assessing corrective action alternatives. The Permittee must also include in the revised Report a revised Table 7-1 to reflect that additional measures, in addition to monitoring of water levels, will be conducted at SWMUs 27-30.		
General Comments	Each comment above addresses issues regarding the Phase III RFI Report. The Permittee's responses are required in either the Phase IV work plan (work plan), the revised Phase III RFI Report (revised Report), or must be addressed in a CMS. The Permittee must also submit a response with the revised Report that details where revisions have been made, cross-referencing NMED's numbered comments. The data gaps discussed above must be addressed in a Phase IV work plan and submitted to NMED no later than December 26, 2008. Separately, the Permittee must address all deficiencies in the revised Phase III Report no later than January 19, 2009. After approval of the Phase III RFI Report, the Permittee must proceed with the remediation evaluation phase and submit a Corrective Measures Study (CMS) work plan.	Comments acknowledged. As previously described, the revised Phase III RFI Report provided as part of this response addresses NMED's comments. Note that Comments No. 11 and 18 ~~will be~~were addressed ~~when~~ pursuant to soil sampling ~~is~~ that was completed for SWMU ~~s~~ 27 ~~though 32~~ during December 2009.	Not Applicable

Table ES-2 – White Sands Missile Range Response to New Mexico Environment Department Comments

Comment No.	NMED Comments	WSMR Response	Section/Page Reference in Revised RFI Report
1	Much of the text in the Report is redundant or repetitive (e.g., Section *6.6.5.2* through Section *6.6.5.2.4)*.The Permittee must revise the Report to remove all redundancies and repetitions.	Revisions to the report have been made to reduce or eliminate redundancies.	Throughout report
2	Currently, multiple sampling events are depicted on a single figure. The Permittee must revise the figures so that sample collection dates are clearly identified (e.g., in the title of the figure, by the sample location ID.	Revisions to figures showing multiple sampling events have been revised to identify sample collection dates.	Figures introduced in Section 6 (RCRA Facility Investmentigation Discussion
3	HMW-5 is included on Table C-1 (Historical Water Levels) and was gauged on January 21, 2009. The Permittee must revise Figure 4-4 or *4-5,* whichever is appropriate, to include HMW*05.*	Figures 4-4 or 4-5 were not included in the previous report. HMW-05 is shown on Figure 4.3-9, near the southern edge of SWMU 146.	Figure 3-9
4	The Permittee must review the Report to ensure that information provided on the revised data tables corresponds to the revised figures. For example, Figure *6.25.6-1* indicates that ~~M1AT-~~MW-33 exceeded MCLs in historical vadose sampling events, but HMW-33 is not included in the two data tables of laboratory results.	The report has been revised to assure that information provided on data tables corresponds to report figures.	Report figures and tables introduced in Section 6 (RCRA Facility Investmentigation Discussions)
5	The ~~4DJM~~ 4DIM are extraneous. The Permittee must remove them from the revised Report, or explain how they add value to the Report.	~~The 4DIM maps provide a 3-dimensional view of the site and are necessary for a reliable understanding of site conditions. Because this type of representation is critical in understanding complexity of the site, the 3-dimensional maps have been provided in an alternative file format (.avi) agreed to by NMED. Four AVI files have been provided that depict still images of 2009 concentrations of TCE, total chromium and benzene in groundwater, along with the spatial distribution of measured~~	~~Appendix C-1~~

Table ES-2 – White Sands Missile Range Response to New Mexico Environment Department Comments

Comment No.	NMED Comments	WSMR Response	Section/Page Reference in Revised RFI Report
		~~water levels in the saturated portions of the vadose zone. Each AVI file depicts views from the four cardinal directions (north, east, south and west) from both aerial oblique (i.e., above ground) and subterranean (i.e., below ground) vantage points.~~The 4DIM files have been removed from the revised Report.	
6	The Permittee references ePrism as a source for online maps of HELSTF. Online maps are not part of the Report submittal. The Permittee must remove all references to ePrism from the revised Report, or include hardcopies of the ePrism maps in the Report.	References to ePrism have been removed from this report.	
7	The Permittee must incorporate relevant figures from the *"Submittal of HELSTF Area Well Logs and Presentation Materials...* "dated March 18, 2009 into the revised Report to facilitate NMED's review.	All materials from the "Submittal of HELSTF Area Well Logs and Presentation Material…" dated March 18, 2009 will not be further incorporated into the Revised Phase III RFI because additional analysis has been performed since the presentation to NMED and therefore, the presentation materials are not current/consistent with the final analysis presented in the RFI report. For example, 2009 groundwater data will be used going forward, and 2004-2008 groundwater data was used in the presentation materials and the Revised Phase III RFI. Another example is the water balance analysis; assumptions in the Phase III RFI changed slightly since the presentation to NMED.	
8	NMED generally concurs with the conceptual site model (CSM); however, the Permittee's arguments related to mass water balance and stable isotopes do not cite supporting data and draw vague conclusions. The Permittee must remove all unsubstantiated statements from the revised Report or provide the supporting information related to such statements.	Statements made in Section 4.3.5.2.1 HELSTF Site Water Balance and Section 4.3.5.2.2 Stable Isotopes and Mixing Analysis have been substantiated by referencing supporting information in Appendix C as well as independent references. The third sentence of the first paragraph in Section 4.3.5.2.1 HELSTF Site Water Balance has been updated as shown below: *"The results indicate an estimated 2.1 gpm currently*	Appendix C-2 Section 4.3.5.2.1 (Page 38) Section 4.3.5.2.2 (Page 40)

Table ES-2 – White Sands Missile Range Response to New Mexico Environment Department Comments			
Comment No.	**NMED Comments**	**WSMR Response**	**Section/Page Reference in Revised RFI Report**
		infiltrates from various water sources (distribution system leaks) over the entire HELSTF area. Based on available information historical infiltration rates may have been as high as 14 gpm ***(Appendix C-2)****."* The third sentence in the third paragraph of Section 4.3.5.2.1 HELSTF Site Water Balance has been updated as shown below: *"*Evaporation *from the sewage lagoons was calculated based on published evaporation rates* ***(Allmendinger, 1971; Appendix C-3)****."* Beginning with the sixth sentence of the third paragraph of Section 4.3.5.2.1 HELSTF Site Water Balance, the paragraph has been updated as shown below: *"Discharge from the reverse osmosis system was reported to be an average of 1.4 gpm from 1995 to 1996 (Appendix C-2). However, based on the available records for the site, no records from 2004 to 2007 were found for the reverse osmosis system, sewage lagoons or cooling tower, therefore, it was assumed that the rates were constant between 1995 and 2007. If this assumption is incorrect, the distribution of infiltration would change but the total estimated amount of infiltration would not change."* The third sentence of the fourth paragraph of Section 4.3.5.2.1 HELSTF Site Water Balance has been updated as shown below: *"Further, because infiltration has been occurring for decades and water levels in the vadose zone are stable or declining* ***(Appendix C-2, Figure 2)****, it can be…"*	

Table ES-2 – White Sands Missile Range Response to New Mexico Environment Department Comments

Comment No.	NMED Comments	WSMR Response	Section/Page Reference in Revised RFI Report
		The third sentence of the second paragraph of Section 4.3.5.2.2 Stable Isotopes and Mixing Analysis has been updated as shown below: *"Samples from the vadose zone had more varied isotopic composition but were generally heavier than both of the groundwater sample groups suggesting that mixing of vadose zone water with upgradient regional groundwater results in the isotopic composition of the downgradient groundwater samples (Appendix C-3, Figure 2)."*	
9	The Permittee must either provide documentation which supports the conclusion in Appendix C-2 (e.g., information supporting the statement that head pressures on parts of the system that may be leaking are most likely variable, or reference to water production rates from 1996-2004, why the same amount of water is ~~pr6duced~~ produced from the R.O. system when less water is produced from the wells) or remove the appendix from the revised Report.	Regarding the reverse osmosis system, discharge through this system was reported at an average rate of 1.4 gpm between 1995 and 1996. However, no records from 2004 to 2007 were found for the reverse osmosis system, therefore, it was assumed that the rates were constant between 1995 and 2007. There is a high degree of uncertainty in this assumption.. With respect to the statement that head pressures on parts of the system that may be leaking are most likely variable, it is known that there is leakage of the pipes occurring based on the water balance analysis, however, it is unknown exactly where the leaky pipes are located. Line pressure will be affected by (1) proximity of the leaks to the pumping source, and (2) volume coming into the site. The further away a leak is from the pumping source, the less line pressure there is. With changing water supply over time and the locations of leaky pipes being unknown, the statement that head pressures on parts of the system that may be leaking are most likely variable is true.	Appendix C-2 Appendix C-2
10	In Section *4.3.5.2.2* Stable Isotopes and Mixing Analysis, second paragraph, page 38, the Permittee states "[a] total	Appendix C-3 is correct. Four samples were collected from the Regional Aquifer at the upgradient portion of HELSTF, rather	Section 4.3.5.2.2 (Page 40)

Comment [JK1]: Note to reviewers-this is not consistent with text. Need clarifications.

Table ES-2 – White Sands Missile Range Response to New Mexico Environment Department Comments

Comment No.	NMED Comments	WSMR Response	Section/Page Reference in Revised RFI Report
	of 23 samples were collected, including 2 samples from the HELSTF water source, 12 samples from the vadose zone, 2 samples from the Regional Aquifer at the upgradient portion of HELSTF, and 5 samples from the downgradient portion of the Regional Aquifer." The total number of samples described in this statement is 21. Table 1 of Appendix C-3 states that there were 23 samples collected for analysis; four samples were collected from the Regional Aquifer at the upgradient portion of HELSTF, rather than the two samples described in the text. The Permittee must revise the text or the Table, whichever is appropriate, to resolve the discrepancy. In general the Permittee must conduct a full review of the Report to check for inconsistencies.	than the two samples described in the text. The first sentence of the second paragraph of Section 4.3.5.2.2. Stable Isotopes and Mixing Analysis has been updated as shown below: *"A total of 23 samples were collected, including 2 samples from the HELSTF water source, 12 samples from the vadose zone, **4** samples from the Regional Aquifer at the upgradient portion of the HELSTF, and 5 samples from the downgradient portion of the Regional Aquifer…."*	
11	Section 4.3.5.2.2 Stable Isotopes and Mixing Analysis, second paragraph, page 38, the Permittee states ". . .the rate of recharge to the Regional Aquifer was estimated to 0.8 to 1.4." The Permittee did not state in what units the rate was expressed. The Permittee must revise the Report to include the appropriate units.	The rate of recharge should be expressed in gallons per minute. The last sentence of the second paragraph of Section 4.3.5.2.2 Stable Isotopes and Mixing Analysis has been updated to reflect these units for recharge.	Section 4.3.5.2.2 Page 40
12	The transmissivity (T) calculated in 1993 was 2.41 to 3.48 &/day. The Permittee states that this estimated T is not representative on a larger scale because it assumes an ideal infinite aquifer, and drawdown tests indicate there is limited hydraulic connectivity between wells at the site; therefore a lower T is more likely. The T calculated by the Permittee's pump tests in 2009 was —'25 ft^2/day; much larger than the T from 1993. This contradicts the Permittee's statement that the 1993 test did not reflect conditions at the site. The Permittee must discuss this discrepancy in the revised Report.	The language used is not clear and creates confusion regarding the different transmissivity values calculated at the Site. The take away point is that in the context of the aquifer variability and heterogeneity inherent at the site, the two values are relatively the same and support the low connectivity observed at the Site.	Section 4.3.5.2.3 Page 41

Table ES-2 – White Sands Missile Range Response to New Mexico Environment Department Comments			
Comment No.	**NMED Comments**	**WSMR Response**	**Section/Page Reference in Revised RFI Report**
13	The Permittee has not conducted a comprehensive background study at HELSTF or across the Facility. Therefore, the Permittee must not make comparisons to background. The Permittee must provide justification for asserting that detected concentrations of selenium, boron, lithium, aluminum, iron, and manganese are naturally occurring, or the Permittee must conduct a background study at the Facility. If the Permittee chooses not to perform a background study at this time, all references to background comparisons must be removed from the revised Report (e.g., Section 4.3.6.1 (Soluble Minerals and their Elements)).	The report has been revised to reference detections of concentrations that have been considered as naturally occurring based upon reviews of professional publications conditions in this region.	Throughout Text

3. Introduction

This document is the Revised Phase III RFI Report, second revision, for the HELSTF at WSMR, White Sands, New Mexico. The HELSTF is a tenant area occupied and operated by the U.S. Army Space and Missile Defense Command (SMDC). The original Phase III RFI Report for the HELSTF sites (WTS, 2008) was submitted to NMED in February 2008. ~~This~~ A Revised Phase III RFI Report was written in response to NMED's letter dated August 27, 2008, Notice of Disapproval Phase III RCRA Facility Investigation (RFI) Report HELSTF Sites, and addresses NMED's comments contained in that letter. The revised Phase III RFI Report was submitted to the NMED during September 2009.

Following the submittal of the Revised Phase III RFI Report, NMED conducted a preliminary review of the document and provided ~~preliminary~~ comment to the Revised RFI Report in a letter dated March 11, 2010, Notice of Disapproval Phase II RCRA Facility Investigation (RFI) Report HELSTF Sites. This current report consists of a second revision that has been prepared in responses to the NMED's August 2008 and March 2010~~preliminary~~ comments.

This report presents current and historical data collected at the sites, including data from the Phase I RFI (International Technology Corporation [ITC], 1992a; b), Phase II RFI (Sverdrup Environmental, Inc. [SEI], 1994), and Phase III RFI (WTS, 2008).

The following sites are discussed in this report.

- SWMUs 23 and 24 – Hazardous Waste Tanks at HELSTF;
- SWMU 25 – Waste Accumulation Area;
- SWMU 26 – Vapor Recovery Unit at HELSTF;
- SWMU 27 – ~~through 30~~ Sanitary Treatment ~~System~~ Impoundment at HELSTF (CCWS-79; WSMR-44);
- SWMUs 31 and 32 – Chemical Waste Tanks (WSMR-43);
- SWMUs 33 and 34 – Fluorspar Tanks (WSMR-49);
- SWMUs 35 and 36 – Ethylene Glycol Tanks at HELSTF (WSMR-50);

- SWMU 37 – Waste Oil Accumulation Area at Building 26121 at HELSTF;
- SWMUs 38 and 39 – ~~Construction~~ HELSTF Landfills (CCWS-75; WSMR-52);
- SWMU 141 – Equipment Storage Area (WSMR-83);
- SWMU 142 – HELSTF Cleaning Facility Sump (CCWS-05, formerly WSMR-48);
- SWMU 143 – HELSTF Storage Yard Chromium ~~Chromate~~ Spill Site (WSMR-54);
- SWMU 144 – HELSTF LSTC Wastewater Discharge ~~Point~~ Pond (CCWS-02; WSMR-47);
- SWMU 145 – HELSTF Test Cell 4 Lagoon~~s~~ (WSMR-53);
- SWMU 146 – HELSTF STP Dry Pond (CCWS-03; WSMR-45);
- SWMU 147 – Decontamination Pad & Underground Holding Tank ~~and UST~~ (WSMR-78);
- SWMU 148 – Former MAR Waste Stabilization Pond (WSMR-83);
- SWMUs 149, 151, and 152 – Septic Systems (WSMR-46);
- SWMU 150 – MAR Dump Site;
- SWMU 154 – HELSTF Systemic Diesel Spill Site (WSMR-55);
- AOC-N – Process Spills at the HELSTF;
- AOC-Q – HELSTF Lab Drains; and
- AOC-V – HELSTF PRS.

3.1 Purpose and Scope

The primary purpose of this Revised Phase III RFI Report (Second Revision) is to present information that characterizes environmental conditions at these sites. Specifically, the report describes the nature and extent of affected media and presents

results from Human Health and Ecological Risk Assessments to support whether corrective measures are required at the sites. This report consists of a revised version of a Phase III RFI Report that was previously prepared during February 2008 and September 2009. This revised report was prepared in response to the NMED's Notice of Disapproval for the previous RFI Reports. The Revised Phase III RFI Report (Second Revision) has been prepared with considerations based on the findings of several comprehensive reports and evaluations, including the following:

- **Revised CSM** – A revised CSM was prepared to provide for a more current interpretation of conditions that govern the fate and transport of constituents at the HELSTF.

- **Background Characterization Study** – A background characterization study was conducted to evaluate background-based concentrations of metals in soil beneath the site. The site-specific background study was supplemented by a comprehensive geotechnical evaluation regarding naturally occurring minerals in soils and groundwater within the Tularosa Basin.

- **Comprehensive Data Evaluation** – A comprehensive evaluation of all data collected during all three phases of the RFI was conducted. Data were evaluated to determine the nature and extent of any release of COPCs from each SWMU addressed as part of the Phase III RFI. Data were evaluated using current criteria established by both the NMED and the U.S. Environmental Protection Agency (USEPA).

- **Risk Assessments** – HHRAs and ERAs were conducted to evaluate the potential for adverse effects from exposure to identified COPCs for both humans and surrounding flora and fauna.

This report provides a description of site background, regulatory history associated with the SWMUs, the environmental setting that serves as the revised CSM, previous environmental assessments, and investigation activities associated with each SWMU. The nature and extent of releases and results of the risk assessments are summarized on a SWMU-by-SWMU basis in this revised report. Conclusions and recommendations for each SWMU are also provided.

3.2 Regulatory History

Environmental restoration activities are being conducted pursuant to RCRA, with regulatory coordination, as appropriate, with NMED and limited participation by the USEPA Region 6. The facility is not on the National Priorities List (NPL).

WSMR completed an Environmental Impact Assessment (U.S. Army, 1975a) for the proposed HELSTF in August 1975 in compliance with the National Environmental Policy Act of 1969. Three existing facilities at WSMR (MAR, NW-30, and LC-37) were evaluated as potential locations of the new complex (i.e., the HELSTF) in order to minimize the impact to the environment and realize savings due to existing infrastructure (i.e., buildings, roads, power, and communications). The assessment concluded that the establishment and operation of the new facility would have no significant impact on the overall environment of the region at any of the three locations.

WSMR submitted a RCRA permit application after the New Mexico Hazardous Waste Management Regulations were published on May 19, 1980. WSMR applied for a RCRA permit in 1984. The RCRA Hazardous Waste ~~permit~~ Permit (No. NM 2750211235) was issued on October 24, 1989, and expired on November 1, 1999. WSMR submitted a renewal application in 1999~~, and as such, the permit remains administratively in force until a new final RCRA permit is issued~~. NMED issued WSMR a draft RCRA Permit in 2007~~. It is anticipated that the final permit will be issued during~~that became final during ~~September~~December 2009.

Initiation of the Installation Restoration Program (IRP) began in August 1988 with a RCRA Facility Assessment (RFA) of WSMR, performed by A.T. Kearney for the USEPA Region 6. The RFA is considered to be the equivalent to the Preliminary Assessment (PA) required by the Comprehensive Environmental Response, Compensation & Liability Act (CERCLA). The purpose of the RFA was to determine whether there was potential for or an actual release of hazardous waste or hazardous waste constituents anywhere at the facility. Distinct locations of potential contamination are referred to as SWMUs. Less defined areas of potential contamination are referred to as AOCs. The RFA report identified 138 SWMUs and 26 AOCs. Among these sites, 17 SWMUs and 3 AOCs were located at the HELSTF. This point is considered the initiation of the WSMR IRP.

~~A RCRA Hazardous Waste Permit (No. NM 2750211235) was issued on October 24, 1989. The RCRA Permit expired on November 1, 1999. WSMR applied for a renewal application in 1999. NMED issued WSMR a draft RCRA Permit in 2007.~~

~~It is anticipated that the final permit will be issued during late 2009. The original permit remains in effect and enforceable until the renewal permit becomes final.~~

The results of the RFA were used by the USEPA to prepare the Hazardous and Solid Waste Amendment (HSWA) Module of the initial Hazardous Waste Permit issued during 1989, which addresses the investigation and corrective actions associated with releases from WSMR SWMUs. The HSWA Corrective Action Module of the Permit contains a listing of WSMR SWMU sites requiring investigation or clean up. ~~The USEPA approved and issued the Permit to WSMR on October 24, 1989.~~ Stipulations of the 1989 Permit required WSMR to investigate and clean up 92 SWMU sites and 4 AOCs.

From 1989 to 1996, the USEPA Region 6 served as the lead regulatory agency with NMED providing review for all work proposed by WSMR. In January 1996, the USEPA relinquished HSWA regulatory authority to NMED. NMED is currently the lead regulatory agency, with the USEPA providing oversight and minimal supplementary assistance.

Before the investigation of SWMUs, the USEPA Region 6 directed WSMR to conduct an Interim Remedial Measure (IRM) to address a leaking UST at the HELSTF. An IRM work plan was submitted to USEPA and NMED in December 1991. WSMR implemented measures to remove "floating" diesel product from the groundwater between 1992 and 2004. This is IRP site WSMR-55 (SWMU 154, HELSTF Systemic Diesel Spill Site).

Since 1988, WSMR has continued to investigate and cleanup sites warranting further action. WSMR has performed numerous voluntary cleanup actions and has conducted groundwater monitoring and soil borings to document the presence or absence of contaminants. WSMR has developed remedial work plans outlining the best procedures for cleanup at remaining sites and petitioned the regulatory authority, NMED, for No Further Action (NFA) rulings on sites at which WSMR has performed cleanup actions and sites determined to have no contamination after completion of investigation(s).

The 92 SWMU sites, identified in Appendices I-IV of the initial 1989 Hazardous Waste Permit, were assessed for releases to the environment during the implementation of the Phase I RFI. The Phase I RFI Report (ITC, 1992a; b) identified 80 SWMUs that required further investigation. Of the 80 sites, 24 were approved for No Further Remedial Action Planned (NFRAP) in September 1993. A modification to the ~~RCRA~~

Initial 1989 Hazardous Waste ~~Part B~~ Permit was initiated, to include this change in the HSWA Corrective Action Module of the Permit. The change was made and approved by USEPA Region 6 in December 1995.

Based on USEPA and NMED direction, WSMR initiated a Phase II Work Plan to further investigate the presence or absence of contaminantes at 52 SWMUs, identified by the Phase I Investigation as containing contaminantes that may pose a risk to human health or the environment. The USEPA and NMED approved the Work Plan in September 1993.

In December 1994, WSMR completed Phase II of the RFI (SEI, 1994), and submitted the report for regulatory review. WSMR received state and federal USEPA Region 6 comments on the Phase II RFI in 1996. Both NMED and USEPA Region 6 issued notices of deficiency (Kelley, 1996; Honker, 1996) regarding the report. NMED emphasized the need to address the SWMUs at the HELSTF differently than those at other locations. WSMR provided their final response to the Notice of Decision (NOD) on September 22, 1997 (Ladd, 1997).

Since then, many environmental restoration activities have been initiated and/or completed on a site-by-site basis. WSMR submitted a series of NFA petitions to the NMED Hazardous Waste Bureau (HWB) beginning in January 2000 for various SWMUs on the WSMR RCRA Permit. The petitions were submitted based on the results of previous investigations and closure reports documenting remedial activities, but were denied by NMED in March 2002 (Frischkorn, 2002) on the basis that further characterization and ERAs were required. During Fiscal Year (FY), 2002, the SWMUs were subsequently reopened, within WSMR's IRP, for further study, and included 18 SWMUs dispersed among 14 related IRP sites.

The sites that were reopened in 2002 are being investigated under two distinct groups: those sites located near the Main Post, and those sites located at the HELSTF. A Phase III RFI Work Plan was developed for those sites located on or near the Main Post. (The Work Plan was subsequently approved by NMED in March 2005.) This effort is commonly referred to as the "Multi-Site Main Post Phase III RFI". This Work Plan includes 15 SWMUs dispersed among 11 IRP sites.

In response to the Phase II RFI comments received from NMED in 1996, WSMR initiated a Phase III RFI investigation at the HELSTF. The Work Plan was subsequently approved by NMED in January 2006. WSMR initiated the field program

in 2006 and 2007. Details pertaining to the scope of the Work Plan are provided under Section 4.5 (Previous Environmental Investigations, page 65).

The field program was implemented in 2007 and the final report was submitted to NMED in February 2008. The SOPs for the field program are provided in Appendix A. Through correspondence dated August 27, 2008, NMED issued WSMR a Notice of Disapproval for the Phase III RFI Report. In response to the Notice of Disapproval, WSMR ~~is submitting this~~ submitted a revised report during September 2009 to address the comments and concerns identified by NMED in its August 27, 2008, Notice of Disapproval. Following a preliminary review of the September 2009 Revised RFI Report, NMED issued a Notice of Disapproval to the Revised RFI Report on March 11, 2010~~09~~. In response to the NMED comments and concerns, WSMR is submitting this second revised report.

4. Background Information

4.1 WSMR Site Description, Land Use, and General Operational History

WSMR is located in south-central New Mexico in a geological province known as the Tularosa Basin. ~~It is located on land contained within five New Mexico counties: Dona Ana, Sierra, Socorro, Lincoln, and Otero.~~ The WSMR Main Post area is 20 miles east of Las Cruces, New Mexico, 50 miles southwest of Alamogordo, New Mexico, and 45 miles north of El Paso, Texas. WSMR boundaries extend almost 100 miles north to south by 40 miles east to west. At almost 3,200 square miles (2,048,000 acres), WSMR is the largest military installation in the country. In addition to the main installation, there are two extension areas located adjacent to the north and west boundaries, and several joint-use land areas. These areas add more than 3.8 million acres to the Installation. WSMR is partially bordered on the east by Holloman Air Force Base and on the south by Fort Bliss Military Reservation. U.S. Highway 70 crosses WSMR from east to west and serves as the main access to the Main Post area. There are no other populated areas located within the boundaries of the facility. A map showing the location of WSMR is provided as Figure ~~1~~2-1.

WSMR is an active installation serving as the U.S. Army's largest rocket and missile development, firing, and testing facility. It is a major center for the testing of new missile systems. WSMR performs applied research, field trials of new missile types, and new applications of existing missile systems. The installation also hosts inter-forces training of troops in a desert environment using tactical exercises for the North Atlantic Treaty Organization (NATO) and Allied Forces. The current

configuration of WSMR includes launch sites, impact areas, instrumentation sites, and support facilities required to develop and test missiles and rockets. WSMR is designated as a National Range focused on the support of missile development and test programs for the Army, Navy, Air Force, National Aeronautics and Space Administration (NASA), and other U.S. and foreign governmental agencies. Thousands of missile firings, airdrops, and static tests have been conducted as part of this mission.

WSMR was established in 1945 for the development of a missile defense program that started with the testing of captured German V-2 rockets. The Range, formerly known as White Sands Proving Ground, was formed from privately held grazing land that was either donated to the government or condemned for the use of the government. WSMR has been active since its establishment with no decrease in land holdings.

4.2 HELSTF Site Description, Land Use, and General Operational History

The HELSTF, a facility at WSMR, is located approximately 18.5 miles northeast of the WSMR Main Post, approximately 2.2 miles north of U.S. Highway 70 (Figure 21-1).

The HELSTF's primary mission is to support the testing and evaluation of high-energy laser systems, subsystems, components, and materials. Within the U.S. Army, the HELSTF has been managed by WSMR and, for the last 17 years, by SMDC.

The area that the HELSTF occupies was originally part of a bombing range. The MAR facility was constructed on the site in 1963. The radar was used to track incoming warheads and guide the missiles to their assigned targets as part of the Nike Zeus Anti-Ballistic Missile System Program. The facility had a large operations building, a small maintenance building, an administration building, and a paved airstrip. The MAR facility was closed in April 1968 when more advanced radar made it obsolete. The buildings later housed the Atmospheric Sciences Laboratory for conducting Electronic Countermeasures studies.

In the mid-1970s, the Department of Defense (DoD) identified the need for a test site to support the continued development of laser weapon systems. WSMR was eventually chosen for the home of the HELSTF and several hundred acres were set aside for its use. The new facility consisted of numerous buildings in five main areas: the LSTC, Test Cell Area (TCA), Fluid Supply Area, the Down Range Test Area, and the

Technical Support Area. The HELSTF began limited operations in July 1982 and became fully operational in September 1985.

The HELSTF was originally operated under the direction of the WSMR Commander. On October 1, 1990, the HELSTF management was transferred to the U.S. Army Strategic Defense Command, and the HELSTF mission was expanded to include Army and DoD research and development efforts, as well as to retain its capabilities for performing test and evaluation support. Today, the HELSTF is operated by SMDC as a tri-service (Army, Navy, and Air Force) entity that tests and evaluates high-energy laser systems, subsystems, and components.

4.3 Environmental Setting and Conceptual Site Model

4.3.1 Demography

WSMR is located on land contained within five New Mexico counties: Dona Ana, which includes the southwest corner of WSMR; Sierra, which includes the west central portion of the WSMR; Socorro, which includes the north and northwest portion of the WSMR; Lincoln, which includes the northeast portion of WSMR; and Otero, which includes the east-central and southeast portion of WSMR (refer to Figure ~~1~~2-1).

The following information was taken from the website http://en.wikipedia.org and is based on data from the 2000 U.S. Census.

Dona Ana County, located on the south side of WSMR, is 3,815 square miles. According to the U.S. Census Bureau, there were 174,682 persons residing within the county in 2000. The population density was 46 people per square mile (18 per square kilometer [km^2]). ~~The racial makeup of the county was 67.82 percent White, 1.56 percent Black or African American, 1.48 percent Native American, 0.76 percent Asian, 0.07 percent Pacific Islander, 24.74 percent from other races, and 3.58 percent from two or more races. Hispanic or Latino of any race comprised 63.35 percent of the population. The median income for a household in the county was $29,808 compared to the medium household income of $51,721 for the whole United States and $42,855 for New Mexico. The median income for a family was $33,576. The per capita income for the county was $13,999. About 25.40 percent of the population and 20.20 percent of families were below the poverty line.~~ The largest city in the county is Las Cruces.

Sierra County, located on the west side of WSMR, is 4,236 square miles. According to the U.S. Census Bureau, there were 13,270 persons residing within the county in 2000.

The population density was 3 people per square mile (1/km²). ~~The racial makeup of the county was 86.97 percent White, 0.48 percent Black or African American, 1.48 percent Native American, 0.17 percent Asian, 0.08 percent Pacific Islander, 8.27 percent from other races, and 2.54 percent from two or more races. Hispanic or Latino of any race comprised 26.28 percent of the population. The median income for a household in the county was $24,152, and the median income for a family was $29,787. The per capita income for the county was $15,023. About 13.80 percent of families and 20.90 percent of the population were below the poverty line.~~ The largest city in the county is Truth or Consequences.

Socorro County, also on the west side of WSMR, is 6,649 square miles. According to the U.S. Census Bureau, there were 18,078 persons residing within the county in 2000. The population density was 3 people per square mile (1/km²). ~~The racial makeup of the county was 62.87 percent White, 0.64 percent Black or African American, 10.92 percent Native American, 1.14 percent Asian, 0.06 percent Pacific Islander, 20.10 percent from other races, and 4.28 percent from two or more races. Hispanic or Latino of any race comprised 48.73 percent of the population. The median income for a household in the county was $23,439, and the median income for a family was $29,544. The per capita income for the county was $12,826. About 24.10 percent of families and 31.70 percent of the population were below the poverty line.~~ The largest city in the county is Socorro.

Lincoln County, located on the east side of WSMR, is 4,831 square miles. According to the U.S. Census Bureau, there were 19,411 persons residing within the county in 2000. The population density was 4 people per square mile (2/km²). ~~The racial makeup of the county was 83.60 percent White, 0.35 percent Black or African American, 1.95 percent Native American, 0.27 percent Asian, 0.06 percent Pacific Islander, 11.28 percent from other races, and 2.48 percent from two or more races. Hispanic or Latino of any race comprised 25.63 percent of the population. The median income for a household in the county was $33,886, and the median income for a family was $40,035. The per capita income for the county was $19,338. About 10.80 percent of families and 14.90 percent of the population were below the poverty line.~~ The largest city in the county is Ruidoso.

Otero County is 6,627 square miles. According to the U.S. Census Bureau, there were 62,298 persons residing within the county in 2000. The population density was 9 people per square mile (4/km²). ~~The racial makeup of the county was 73.71 percent White, 3.92 percent Black or African American, 5.80 percent Native American, 1.17 percent Asian, 0.13 percent Pacific Islander, 11.67 percent from other races, and~~

~~3.60 percent from two or more races. Hispanic or Latino of any race comprised 32.16 percent of the population. The median income for a household in the county was $30,861, and the median income for a family was $34,781. The per capita income for the county was $14,345. About 15.60 percent of families and 19.30 percent of the population were below the.~~ The largest city in the county is Alamogordo.

4.3.2 Potential Ecological Receptors

Based on field reconnaissance and literature review, the predominant habitat at the HELSTF is desert basin scrub. Five ecological receptor types near the HELSTF were identified (U.S. Army Corps of Engineers [USACE], 1989). These include flora and four types of fauna (reptiles, amphibians, birds, and mammals).

Yesum-Holloman series soils support sparse vegetation cover dominated by four-wing saltbrush, dropseed grasses, and snakeweed. With the exception of the facility sewage lagoons, very little habitat exists at the HELSTF to attract waterfowl. However, many upland bird species inhabit the area. Many species of transient birds periodically use the area as they pass through during migration. The predominant and common flora, reptiles and amphibians, birds, and mammals occurring near the HELSTF are listed in Tables 4-~~.3-~~1 through 4-~~.3-~~4.

As specified under the Phase III RFI Work Plan, it was determined to be unlikely that any Federal or State listed threatened or endangered species would be found to occur near or within the HELSTF (WTS, 2006).

Websites used to gather information on potential species included the US Fish & Wildlife Service Southwest Region (www.fws.gov/southwest/es/NewMexico), the New Mexico Department of Game & Fish Biota Information System of New Mexico (www.bison-m.org), and Natural Heritage of New Mexico (nhnm.unm.edu/rank_status/sstatusvalues.html).

4.3.3 Topography and Surface Drainage

WSMR is located in the Tularosa Basin of southwestern New Mexico (Figure 4-1). The Tularosa Basin is a north-south oriented, closed basin at an average elevation of 4,000 feet above mean sea level (ft amsl). The valley floor has minimal topographic relief and ephemeral lakes and alkali flats are present.

Figure 4.3-1 depicts the regional topography of the basin in the vicinity of WSMR. The basin is bounded to the west (from south to north) by the Franklin, Organ, and

San Andres Mountains, to the north by the Oscura Mountains and the Carrizozo Volcanic Field, to the east (from north to south) by the Sierra Blanca and Sacramento Mountains (Sacramento uplift), and to the southeast by the Otero Platform. The Jarilla Mountains occur as minor topographic uplift on the southeastern side of the basin floor. Peaks on the eastern side of the basin reach elevations of ~~nearly~~approximately 12,000 ft amsl (Sierra Blanca Peak), whereas peaks on the western side of the basin reach elevations of just 9,000 ft amsl (Salinas Peak). A topographic divide separates the Tularosa Basin from the Hueco Basin to the south.

The Tularosa Basin is internally drained with no surface water outlets. Ephemeral streams (arroyos) drain from the west into the Tularosa Basin and generally exhibit meaningful flow after heavy precipitation events. Perennial streams predominantly drain from the east into the Tularosa Basin. Most surface drainage is toward the center of the basin.

Very little permanent surface water exists at WSMR due to the low annual precipitation, high evapotranspiration rates, and moderate infiltration characteristics of the soil. Lake Lucero, the most prominent expression of surface water, is usually dry. Lake Lucero is located in the heart of the Alkali Flats approximately 6 miles northwest of the HELSTF (Figure 4.3-1). The only perennial surface water at the site is found in man-made sewage effluent ponds.

The HELSTF itself is located in a subtle topographic low, with no major through-flowing drainage. Local surface drainage is contained in engineered, but unlined, channels and diverted through the site.

4.3.4 Geology

4.3.4.1 *Description of Regional Geology*

The Tularosa Basin is located within the Mexican Highland Section of the Basin and Range physiographic province. The basin is the result of tectonic rifting (crustal extension) associated with development of the Rio Grande Rift (linear arm of the Basin and Range physiographic province), which began in the region about 35 million years ago (Seager et al., 1984). The rifting produced north-northwest trending, fault-zone bounded valleys (grabens or half-grabens) with large-displacement normal faults. Figure 4.3-2 depicts two regional geologic cross-sections through the Tularosa Basin and surrounding mountain ranges.

The Alamogordo Fault Zone, which bounds the eastern side of the basin, extends from the Carrizozo Volcanic Field southward along the western margin of the Sacramento Mountains to the Otero Platform, located approximately 30 miles east of the HELSTF (Figures 4.3-1 and 4.3-2) (Fryberger, 2008). The most recent faulting event along the Alamogordo Fault Zone occurred in the northern segment during the Holocene (<10,000 years ago) (Machette et al., 1998). A major north-south trending fault occurs along the central axis of the basin just west of the Jarilla Mountains and east and southeast of the HELSTF (Figures 4.3-1 and 4.3-2) (Seager et al., 1984). This central fault separates the shallow eastern portion of the Tularosa Basin from the deep western portion (Figure 4.3-2). The San Andres, Organ Mountain, and Artillery Range fault zones, which bound the western side of the basin, represent the largest basin-bounding fault system with more than 15,000 feet of structural throw (Figures 4.3-1 and 4.3-2). The most recent faulting event along this major fault system occurred along the southernmost segment during the Holocene (Machette et al., 1998). This westernmost fault zone within the basin is located 5 miles west of the HELSTF. Visible fault scarps related to recent fault activity have been observed on alluvial fans along the mountain fronts and in the valley (Seager et al., 1984; Blair et al., 1990; Buck, 1996).

The San Andres, Organ, and Franklin Mountains (San Andres uplift) located west of the HELSTF are composed of more than 5,000 feet of westward-dipping, Precambrian-Pennsylvanian age bedrock and Cretaceous-Tertiary intrusive rocks (Figures 4.3-1 and 4.3-2) (Kottlowski et al. 1956; McLean 1970). The Sacramento and Sierra Blanca Mountains (Sacramento uplift) located east of the HELSTF are composed of more than 3,300 feet of Cambrian-Pennsylvanian and Permian age bedrock (Figures 4.3-1 and 4.3-2) (McLean 1970). Over geologic time, dissolution and mechanical weathering of Paleozoic sedimentary series in the basin-bounding mountains (e.g., Permian Yeso Formation) provided the source of gypsum and other evaporite minerals (mineral salts) in the Tularosa Basin. The Jarilla Mountains, located approximately 20 miles southeast of the HELSTF, form isolated bedrock outcrops in the valley floor composed of a large Tertiary intrusive body associated with regional extension and rifting.

Tertiary deposits are thickest in the deep structural trough associated with rifting along the western margin of the basin. Sediment accommodation in the trough ranged from 3,000 feet in the north to more than 9,000 feet near New Mexico-Texas border (Hibbs et al., 1997). Sediment accommodation in the northeastern portion of the basin (a shallower platform) was significantly smaller with basin fill thicknesses ranging from only 2,000 to 3,000 feet near Alamogordo to less than 1,000 feet in the vicinity of the Jarilla Mountains (Hibbs et al., 1997). Based on regional basin fill thicknesses, more

than 2,000 feet of Tertiary basin fill was likely deposited beneath the HELSTF (Hibbs et al., 1997).

The Tertiary deposits of the Tularosa Basin record the onset of volcanism and extensional tectonics in late Oligocene time. Throughout the Rio Grande Rift, beginning in the Oligocene and accelerating in the late Miocene, rising mountains shed coarse detritus into rapidly subsiding extensional basins via meandering sandy rivers and alluvial fans (Seager et al., 1984). These processes have all operated in a climate that has grown increasingly arid. Throughout the history of basin sedimentation, coarse clastic fluvial and sheetflood sedimentation was interrupted at various times by lacustrine episodes that deposited clays, marls and siltstones, particularly during pluvial episodes (extended periods of abundant rainfall) of the Pleistocene.

The Love Ranch Formation and the various overlying formations of the Santa Fe Group are the principal valley fill clastics in and around the Tularosa Basin. Significant lenses of volcanic rocks occur in the lower portion of the basin fill (Wilkins, 1986). The origin of the basin fill belongs to the ancestral Rio Grande, which once flowed through Fillmore Pass and into the Tularosa Basin, supplying sand and gravel (e.g., Pliocene Camp Rice Formation of the Santa Fe Group). The river was subsequently entrenched into its current location around 225,000 years ago. Alluvial fan facies of the Camp Rice Formation are currently exposed along the mountain front southwest of Lake Lucero (Playa Lucero) and immediately west of the HELSTF (Fryberger, 2008). A larger expanse of Camp Rice Formation fluvial facies are exposed south and southeast of the HELSTF (Fryberger, 2008).

Overlying the ancestral Rio Grande deposits are extensive lacustrine clay and fluvial sands and silts of Pleistocene to recent age that are several thousand feet thick in the depocenter of the basin. The Late-Pleistocene to Quaternary stratigraphy of the area records pluvial events of the glacial periods, the most important of which (in terms of surface geology) was the latest Pleistocene (Wisconsin) glaciation and de-glaciation. During glacial periods, weather in the Tularosa Basin was cooler and wetter than at present with lower evapotranspiration, which effectively flushed gypsum into the basin from the basin-bounding bedrock. The most recent pluvial Pleistocene Lake was ancient Lake Otero, which occupied the central-western portion of the Tularosa Basin (encompassing the HELSTF). Wetter conditions led to higher lake levels for Lake Otero that were maintained by higher groundwater infiltration and fluvial runoff (highstand shoreline at approximately 4,020 ft amsl) (delineated in Figure 4.3-1). These deposits have a basin-centered pattern. Permeable fluvial sands and gravels from alluvial fans are found along the basin

margins, whereas less permeable silty or evaporitic facies are found in the lowest, central portions of the basin.

Following a period of aridification that began more than 10,000 years ago (last glacial retreat), Lake Otero began to dry up, precipitating 10 to 30 feet of gypsiferous evaporites (late phase of Lake Otero deposition). Caliche and selenite crystals and discs redeposited from solution have been observed as discrete layers. The gypsiferous beds in the vicinity south of Lake Lucero are interbedded with alluvial sediments deposited while Lake Otero was contracting (Fryberger, 2008). Approximately 7,000 years ago, an active eolian deflation basin cut into Lake Otero deposits and redistributed the gypsum to form the present-day dune fields. Alkali Flats and Lake Lucero are the remnant lake bed of ancient Lake Otero (Figure 4.3-1).

The narrow, 45-mile long Malpais Lava Flow (Carrizozo Volcanic Field) on the northern margin of the Tularosa Basin is very distinctive on satellite or aerial imagery (Figure 4.3-1). The dark volcanic rocks stand in high contrast to the surrounding, light-colored basin fill. The lava flow represents two Holocene volcanic eruptions that occurred approximately 5,000 years ago (New Mexico Bureau of Geology and Mineral Resources, 2008).

Depositional environments responsible for the distribution of Tertiary basin fill consisted of alluvial fan deposition along the basin margins (proximal facies); a transitional zone of sand and gravel deposition (riverine systems); and clay-dominated, lacustrine, and evaporite deposition in the basin interior (distal facies) (Kelly, 1973). However, it should be noted that the spatial distributions of facies within the basin were variable over geologic time and were largely controlled by the rate of tectonic subsidence (i.e., volume available for sediment accommodation), paleoclimate, and sediment load.

At present-day, large precipitation events that mostly occur during the summer monsoon (July to September) generate sheet wash deposits and torrential streams (channelized flow) that incise into Pleistocene deposits along the basin margins (e.g., Andrecito Creek located northwest of Lake Lucero), with a decreasing grain size toward the basin center for non-gypsiferous sediments. The valley floor consists of complex systems of interrelated active dune and interdune systems, eolian sand sheets and eolian sabkhas (Fryberger, 2008). Active gypsum dune systems exist east and north of Alkali Flats along the axis of the central and northern portions of the basin (Fryberger, 2008). Active quartzose dune systems exist at two locations: north and west of the Jarilla Mountains and in the northernmost portion of the basin near the

southern toe of the Malpais Lava Flow (Fryberger, 2008). The HELSTF is located in an inactive dune system of eolian gypsum sand (Fryberger, 2008). Wind erosion (also referred to as wind scour) plays an active role in shaping the present-day landscape within the basin (e.g., eolian sediment distribution).

4.3.4.2 *Description of Local Geology*

The HELSTF is located near the depositional axis of the Tularosa Basin, just south of the eolian gypsum dunes of the White Sands National Monument (Figure 4.3-1). As a result of the basin interior setting and the proximity to the source of the eolian gypsum sand, the subsurface geology at the HELSTF consists of two distinctive geologic zones. The youngest stratigraphic zone (defined as the gypsiferous zone) is associated with the geologically recent aridification of the basin. The underlying stratigraphic zone (defined as the interbedded zone) is associated with a Pleistocene paleo-lake margin setting. Previous correlations of site stratigraphy to geologic formations or significant Tertiary depositional events within the Tularosa Basin were unavailable. The following interpretations are based on comparisons of existing boring log information with published literature. All available boring logs for the HELSTF are included in Appendix B.

An extensive review of boring log records for the HELSTF site was utilized to construct cross-sections to a maximum depth of 90 feet below ground surface (ft bgs) at some locations (Figures 4.3-3, 4.3-4, and ~~through~~ 4.3-5). The cross sections indicate a white, gypsiferous eolian silt and minor sand deposits with frequent occurrences of selenite crystals and hardpans (gypcrete crusts), which varies in lateral thickness (10 to 35 ft bgs). Neher and Bailey (1976) defined the shallow soils in the vicinity of the HELSTF as “Yesum-Holloman and Gypsum land” consisting of 35 percent eolian deposits (Yesum), 30 percent ancestral lacustrine deposits (Holloman), and 20 percent Lake Otero gypsum crystals or evaporites (Gypsum land). Basabilvazo et al. (1994) report the occurrence of varved, gypsiferous clay and silt of lacustrine origin in this shallow zone (upper 15 to 20 feet of soil profile). Collectively, these observations indicate this zone is consistent with shallow, inactive Quaternary gypsum dunes (which surround the HELSTF) that are in turn underlain by Pleistocene Lake Otero evaporitic beds (late phase of deposition). Similar thicknesses of Lake Otero evaporites (10 to 25 feet) were observed at test holes drilled around the margin of Lake Lucero (Almendinger, 1971). The underlying Pleistocene evaporitic beds are noted to have very low infiltration rates.

Underlying the gypsiferous deposits is a thick (a minimum of 80 feet) clay-dominated, interbedded zone with silt and channel fill sand deposits. The interbedded zone suggests the site was located between the transitional zone (riverine systems) and distal facies (lacustrine) depositional environments of the Pleistocene (i.e., lake margin setting) and is consistent with the typical non-evaporite lacustrine lithologies of sand, silt, and clay of Lake Otero (early phase of deposition) and possibly older, pre-Otero pluvial lakes (e.g., Pliocene Lake Cabeza de Vaca) (Almendinger, 1971). Individual channel fill sand deposits typically range in width from 100 to 500 feet and range in thickness from a few feet to 15 feet. The channel fill sand deposits appear to have a northeast-southwest channel orientation, which would indicate the riverine systems flowed eastward, away from the mountain front (i.e., orthogonal to the nearby San Andres Mountains), as depicted in Figure 4.3-5. Stacked channels appear to produce thick vertical sections of permeable sand (up to 25 feet). More than 2,000 feet of laterally continuous channel fill sand deposits were noted in cross sections drawn parallel to channel orientations, which may be an indication that the Late Pleistocene riverine systems had minor sinuosity. The three-dimensional distribution of the channel fill sands at the site was likely the combination of stream avulsion, sediment load, tectonic subsidence, and paleoclimate.

The site boring log record characterizes site geology at the HELSTF from land surface to 90 ft bgs, approximately 20 feet below the Regional Aquifer groundwater surface. Previous work by others indicates a laterally continuous, yellowish-brown silty sand below 90 ft bgs and a regionally continuous clay at approximately 1,000 ft bgs (Kelly and Hearne, 1976).

Limited lithologic information is available for interpretations of site stratigraphy below the regional water table. In addition, the spatial distribution of soil boring locations at the HELSTF was focused on the northern portion of the site near the HELSTF Systemic Diesel Spill (SWMU 154) and HELSTF Storage Yard Chromium ~~Chromate~~ Spill Site (SWMU 143), as well as the southernmost portion of the site southwest of the Sewage Lagoons (SWMU 27 - Sanitary Treatment Impoundment at HELSTF~~through 30~~) (Figure 4.3-3).

4.3.5 Hydrogeology

The mean annual precipitation in the basin-bounding mountains is 26 inches per year, in contrast to an average of only 8 inches per year in the valley floor (Hibbs et al., 1997; Fryberger, 2008). A significant difference in precipitation exists between the western mountains (e.g., San Andres Mountains), which receive 14 to 16 inches per year, and

the eastern mountains (e.g., Sacramento and Sierra Blanca Mountains), which receive more than 30 inches per year (Hibbs et al., 1997; Fryberger, 2008). As a result, ephemeral (intermittent) streams drain from the west into the Tularosa Basin and perennial streams drain from the north and the east with a greater contribution to basin recharge. Although precipitation records indicate the greatest rainfall during the summer monsoon (July to September), the most significant recharge occurs during long-duration, winter frontal systems in January through March (McLean, 1970). Seasonally high evaporation rates and strong winds (especially in the spring) account for the difference.

There are several perennial streams in the closed Tularosa Basin, which include Salt Creek, Lost River, Three Rivers, Tularosa Creek, and Indian Creek. Other surface water features with limited surface water transport include several springs located along the basin margins (Mound Springs, Salt Springs, Cowen Spring, Chosa Spring, Aguilar Spring, Lamitas Spring, Harkness Spring, Lewis Spring, Brazel Spring, Scholler Spring, Kitty Spring, Malpais Spring, and Alkali Spring). Salt Creek and Malpais Spring are believed to be the only surface water features sustained by groundwater discharge within the basin (Huff, 2005). Flow ranges from 250 to 450 gpm in Salt Creek and from 220 to as much as 1,500 gpm in Malpais Spring (McLean, 1970).

4.3.5.1 *Regional Aquifer*

A topographic surface divide separates the Tularosa Basin from the Hueco Basin to the south along the New Mexico and Texas state line. However, the two basins are generally considered a continuous Regional Aquifer (Tularosa-Hueco Aquifer System). Groundwater flow is generally toward the basin center from the basin margins with an axial pattern of southward flow along the western, deepest side of the basin (Figure 4.3-6) (Fryberger, 2008). The average linear groundwater velocity at the regional water table is highest in the northern basin (more than 25 feet per day [ft/day]), moderate along the basin margins (approximately 5 ft/day), and lowest in the basin center (less than 1 ft/day) (Fryberger, 2008). The regional groundwater elevations beneath the HELSTF range from approximately 3,881 to 3,886 ft amsl, with a southeasterly flow direction (Figure 4.3-7). Further discussion of local groundwater conditions is provided in Section 4.3.5.2 (page 36).

Concentrations of TDS are less than 1,000 milligrams per liter (mg/L) along the basin margins; however, the regional groundwater is generally brackish to saline (e.g., at the HELSTF TDS exceeds 10,000 mg/L in all wells in the Regional Aquifer), and TDS concentrations increase with proximity to the basin center and with aquifer depth

(Figure 4.3-~~89~~) (Hibbs et al., 1997; Fryberger, 2008). Very high TDS values even exceed 35,000 mg/L at some locations (e.g., Lake Lucero and Alkali Flats). As a result of the distribution of elevated salinity within regional groundwater, only freshwater lenses along the basin margins exhibit low enough TDS to typically be considered appropriate for water supply and use.

The U.S. Geological Survey (USGS) conducted deep well installations in 1990 and water quality sampling of the Regional Aquifer from 1984 to 1990 in the vicinity of the HELSTF (Basabilvaso et al., 1994). Elevated levels of chloride, sulfate, calcium, magnesium, and sodium, along with detected concentrations of barium and dissolved chromium, were detected in off-site test wells (HELSTF-2 and HELSTF-3) located approximately 0.6 mile northwest of the HELSTF, as well as in an on-site test well (HELSTF-1) and water supply well (MAR-CW). All four wells are screened in the Regional Aquifer. Two wells in particular (HELSTF-2 and HELSTF-3) are screened significantly deeper from 80 to 500 ft bgs. Basabilvaso et al. (1994) concluded that concentrations of chloride and dissolved solids increase with depth in the Tularosa aquifer system, whereas the concentration of sulfate decreases with depth.

Sulfate and chloride are common throughout the Regional Aquifer. Sodium chloride is predominant in more than 90 percent of the regional groundwater. However, McLean (1970) reported that predominant ions vary considerably in the shallow 3,000 to 10,000 mg/L salinity unit and may also include calcium chloride, sodium sulfate, calcium sulfate ($CaSO_4$), and calcium magnesium sulfate (Figure 4.3-~~98~~). The majority of these ions were sourced from Paleozoic rocks along the basin margins, most notably the Permian Yeso Formation. The Yeso Formation is a mixed marine association of carbonates (dolostones and limestones), evaporites (large amounts of gypsum), and clastics that extends across the southern part of the Colorado Plateau. It is generally believed to have been deposited in coastal sabkha and eolian environments (Stanesco, 1991). The Yeso Formation can range in thickness from approximately 1,580 feet in the San Andres Mountains, up to 1,800 feet in the southern Sacramento Mountains, and up to 4,260 feet in the northern Tularosa Basin (Bates, 1961; McLean, 1970). Groundwater yield from the Yeso Formation has been reported as highly saline. Naturally elevated concentrations of barite and selenium also occur in the Regional Aquifer because barite and selenium can substitute for calcium and sulfur in gypsum ($CaSO_4$), respectively.

Groundwater recharge generally occurs through bedrock and permeable basin fill (e.g., alluvial fans) along the mountain fronts, which are supplied by ephemeral and perennial streams that drain the mountains, particularly along the eastern margin of the

basin (Hibbs et al., 1997; Waltemeyer, 2001). Salinity distributions further attest to freshwater recharge along mountain fronts (Figure 4.3-9~~8~~). Recharge rates for the entire basin are much less than groundwater withdrawals (Creel and Hawley, 2001). Waltemeyer (2001) estimated that mean annual basin stream flow was 95 cubic feet per second (approximately 3 billion cubic feet annually) and that only 1 percent to 9 percent of total precipitation is recharged to regional groundwater. Orr and Risser (1992) estimated that only 7 percent of annual stream flow into the basin is recharged. It is unlikely that precipitation falling on the basin floor contributes meaningful amounts of groundwater recharge due to the low precipitation rates, high evaporation rates, and very low infiltration rates (Huff, 2005).

High seasonal evaporation on the playas can exceed 100 inches per year. The evapotranspiration extinction depth (maximum depth at which evapotranspiration occurs) near Holloman Air Force Base was estimated to be around 15 ft bgs (Burns and Hart, 1988). Contrary to the seasonal precipitation peak (July to September), the most significant recharge occurs during long duration, winter frontal systems (January to March) as a result of significantly lower evaporation rates and reduced winds. Freshwater recharge often creates dissolution features (e.g., solution cavities) within the Pleistocene (and older) lacustrine deposits along the basin margins (Weber, 1964; Wier, 1965; Almendinger and Titus, 1973). Surface water evaporation occurs at numerous lakes (Lumley Lake, Big Salt Lake, Foster Lake, and Lake Lucero) and at several springs along the basin margins. However, only Salt Creek and Malpais Spring are believed to discharge groundwater. Other surface water features are believed to be entirely fed by precipitation runoff.

Water supply from the Tularosa Aquifer is generally pumped from production wells within the alluvial fans (less than 1,400 gpm at high elevations and 300 to 700 gpm at the lower elevation fan edges) (Hibbs et al., 1997). Basin center supply wells typically yield less than 100 gpm (sometimes less than 15 gpm). Groundwater pumping is mostly from alluvial fans of the Camp Rice Formation. The alluvial fans have a wide range in hydraulic conductivity values due to poor sorting and extreme heterogeneity.

Interbasin flow occurs southward into the Hueco Bolson aquifer, which is ultimately discharged to the Rio Grande or downgradient pumping wells. Estimates of pre-development (pre-1940) discharge through interbasin flow range from 4.6 to 7.4 million cubic meters per year (2,880 to 6,000 acre-feet per year) (Orr and Risser, 1992; Heywood and Yager, 2003; Sheng and Devere, 2005; Druhan et al., 2008). Drawdown from pumping in the Hueco Bolson aquifer to the south has induced an additional 12.3 million cubic meters (10,000 acre-feet per year) of through flow from the

Tularosa aquifer (19.7 million cubic meters total) as of 2002 (Sheng and Devere, 2005; Druhan et al., 2008).

4.3.5.2 *Local Groundwater Conditions*

At the HELSTF, groundwater flow in the Regional Aquifer is toward the southeast with an average hydraulic gradient of approximately 0.002 foot per foot, based on recent water levels collected January 21 and 22, 2009, which is consistent with expectations of the regional groundwater (Figures 4.3-6 and 4.3-7). The regional water table is typically encountered between 70 and 75 ft bgs at most locations at the Site (Figures 4.3-4 and 4.3-5). Previous aquifer testing (ITC, 1992c) indicates the hydraulic conductivity and storativity values of the Regional Aquifer are about 5.2 ft/day and 0.0048, respectively.

Previous investigations detected the presence of vadose zone water above the Regional Aquifer surface. Previous assessment reports for the HELSTF site referred to the vadose zone water as perched groundwater zones. However, as discussed in detail below, this terminology does not ~~accurately~~ best describe the site conditions. The vadose zone water originated from known infiltration sources including the Sanitary Treatment ~~System~~ Impoundment at HELSTF (SWMUs 27 ~~through 30~~), Former MAR Waste Stabilization Pond (SWMU 148), leaking water and sewer lines, the HELSTF LSTC Wastewater Discharge ~~Point~~ Pond (SWMU 144), the HELSTF STP Dry Pond (SWMU 146), and infiltration from the on-site reverse osmosis system.

Saturated intervals above the regional water table were confirmed in existing boring log records from on-site investigations with depth to vadose zone water occurring as shallow as 10 ft bgs in some locations (e.g., HMW-19) (Figures 4.3-4 and 4.3-5). Vadose zone water occurs within the lowest portion of the gypsiferous zone and throughout the interbedded zone (Figures 4.3-4 and 4.3-5). The shallowest saturated intervals were observed beneath the former Sanitary Treatment ~~System~~Impoundment (SWMU 27). However, shallow monitoring wells are limited to locations south of the HELSTF Systemic Diesel Spill Site (SWMU 154) and preclude the identification of other similarly shallow saturated zones (Figure 4.3-~~9~~10). Previous investigations have indicated the occurrence of a relatively continuous clay zone between approximately 60 ft bgs and the Regional Aquifer groundwater surface (approximately 70 to 75 ft bgs).

Saturated soil intervals within the interbedded zone above the Regional Aquifer tend to occur predominantly within the permeable channel fill sand deposits (Figures 4.3-4 and 4.3-5). In some locations, these saturated sand intervals are laterally continuous

between borehole locations. Vertically saturated intervals of up to 30 feet were noted within vertically continuous, stacked channel fill sands at some locations (e.g., HMW-57) (Appendix B). However, saturated clay intervals were also observed at several locations. In general, the channel fill sands in the interbedded zone likely represent zones of high hydraulic conductivity relative to surrounding clay and clayey silts and may serve as the primary pathways for lateral and vertical migration of vadose zone water down to the Regional Aquifer. A conceptual depiction of the complex infiltration and moisture content distribution in the vadose zone beneath the HELSTF is show in Figure 4.3-11.

Lateral flow within these primary flow paths is inhibited as a result of the depositional mechanism (i.e., eastward flowing riverine systems) responsible for the channel fill sand deposits, which created lateral discontinuity, particularly in the northwest-southeast direction. The existence of the semi-linear, high permeability channel fill sand deposits indicates that preferred groundwater flow paths exist in a northeast-southwest direction in the interbedded zone (Figure 4.3-5). The lenticular geometries of the interbedded sand, silt, and clay also create significant vertical anisotropy and direction-specific horizontal anisotropy in the northwest-southeast direction (Figure 4.3-4). Overall, the observed saturated intervals in the vadose zone indicate that complex, three-dimensional flow paths likely exist for vadose zone water at the site as a result of anisotropic conditions within the interbedded zone. The occurrence of connected flow paths precludes the conventional use of “perched” to describe vadose zone water.

Although water saturation in the vadose zone is spatially variable with limited horizontal connectivity, the net water flux is downward with a complex cascade-type pattern (Figure 4.3-8). Water in the vadose zone, including water measured by wells screened in locally saturated materials, is not capable of sustaining meaningful yields and is most correctly described as vadose zone water. The average evapotranspiration extinction depth is approximately 15 ft bgs (see Section 4.3.5.1, page 33) and vadose zone water below this depth is generally not likely to be removed by evapotranspiration, although much of it is subject to drainage to the Regional Aquifer over time.

A comprehensive round of water levels measured in the vadose zone in January 2009 ranged from 19 to 51 ft bgs (Table 4-5). Due to the vertical and lateral anisotropy of the vadose zone and resulting cascade-type pattern of vadose zone water migration, conventional two-dimensional water level maps tend to produce highly variable head representations that in turn misrepresent the potential for lateral flow because they cannot represent localized variations in lateral connectivity. . ~~Instead, vadose zone~~

water above the Regional Aquifer is depicted in a three-dimensional groundwater model (as .avi files) of depth-to-water measurements and saturated screen intervals within the vadose zone is presented in Appendix C-1. The spatial distribution of saturated screen intervals within the vadose zone is consistent with the revised CSM. (i.e., they demonstrate that the vadose zone is not continuous and uniform under the HELSTF). (Figures 4.3-4 and 4.3-5). Historical water levels measured at the site between April 1990 and January 2009 are presented in Appendix C-1.

4.3.5.2.1 HELSTF Site Water Balance

As indicated above, the presence of vadose zone water is primarily the result of infiltration from various sources attributable to the site operations. A water balance (Appendix C-2) was performed for the HELSTF area to estimate the flux of water infiltrating the vadose zone and to estimate the potential for recharge and corresponding contaminant migration to the Regional Aquifer. The results indicate it is likely that approximately 2.12 gpm currently infiltrates from various water sources (distribution system leaks) over the entire HELSTF area, and that historical infiltration rates may have been as high as about 14 gpm (Appendix C-2). The observed saturated soil within the vadose zone is a result of this infiltration and heterogeneous saturated soil conditions are expected to remain unless the infiltration decreases significantly.

The water balance was based on metered annual water production data from 2004 to 2007, daily metered and estimated water production and usage from a 290-day period in 1995 and 1996, and published pan evaporation rates from the climate station at Elephant Butte Dam. Water Supply Wells MAR-1, MAR-2, and MAR-3 are the only source of water for the HELSTF area and formed the basis for the water balance. Water losses include evaporation from the cooling tower and the sewage lagoons as well as infiltration to the subsurface. The difference between supplied water and evaporation was assumed to infiltrate. The soil at the HELSTF contains gypsum, which dissolves and corrodes metal piping due to a high ionic strength. Leaking pipes are expected to continue as a function of time unless the corroded piping is repaired; however, the rate of leaking will at a decreasinglikely decrease rate due to continued less water continuously being used usage at the facility.

The average water production during 1995 and 1996 was approximately 31.932 gpm (16.8 million gallons per year) and had decreased to an average of 23.123 gpm (12.1 million gallons per year) by the period between 2004 and 2007. Water use records at the cooling tower indicate that approximately 11 gpm evaporated from the

cooling tower. Evaporation from the sewage lagoons was calculated based on published evaporation rates (Allmendinger 1971; Appendix C-2). The potential evaporation rate from the sewage lagoons was estimated to be ~~7.2~~ 7gpm. Infiltration from unlined ponds was based on the observed vertical hydraulic conductivity (Appendix C-2). The calculated infiltration rate for the unlined ponds was ~~1.5~~approximately 1-2 gpm. Discharge from the reverse osmosis system was reported to be an average of 1.4 gpm from 1995 to 1996 (Appendix C-2). No records from 2004 to 2007 were found for the reverse osmosis system, sewage lagoons or cooling tower, therefore, it was assumed that the rates were constant between 1995 and 2007. If this assumption is incorrect, the distribution of infiltration would change but the total estimated amount of infiltration would not change. The estimated total infiltration for the HELSTF was approximately ~~2.1~~2 gpm during the 2004 to 2007 time period and as high as approximately 14 gpm based on the 1995 and 1996 data. Though a certain degree of uncertainty is associated with the assumptions that are built into the water balance analysis, the estimate of total infiltration indicates that a significant volume of water has infiltrated during historical site operations at the HELSTF, and that infiltration continues at present, though to a lesser extent. Further, because infiltration has been occurring for decades and water levels in the vadose zone are stable or declining (Appendix C-2, Figure 2), it can be concluded that the system has the capacity to accommodate the current infiltration rate without further accumulation or lateral migration of vadose zone water.~~, and that recharge potential to the Regional Aquifer is greater than current infiltration rates~~

Leaking sewer and water lines distributed throughout the HELSTF area have contributed to elevated infiltration rates at the Site. Therefore, when Site activities began to lessen, the amount of water traversing through the pipes was reduced, resulting in a lower artificial contribution to infiltration. Stable and/or declining water levels observed within vadose zone wells ~~support the~~ indicate that there has been a reduction of infiltration to the vadose zone. Reduced infiltration to the vadose zone implies that there is less risk of vadose zone contaminants ~~from~~ reaching the regional aquifer.

Water level trends were evaluated for 47 of 65 monitoring wells screened in the vadose zone of the HELSTF area and the data show water levels in most wells are stable or declining. In summary~~.~~:

- 27 wells exhibited declining water levels
  - Datasets ranged from 2 to 23 readings per well
- 14 wells displayed stable water levels (water level change of less than 1 foot)

- Datasets ranged from 2 to 19 readings per well

- 6 wells showed increasing water levels
  - Datasets ranged from 2 to 19 readings per well

- Trends were not evaluated for 18 wells due to limited datasets (less than 2 readings)

For the 41 wells with stable or declining water levels, screen intervals range from 27 (HMW-37) to 63 (HMW-15) feet below ground surface (ft bgs). This implies that effects from reduced infiltration are not limited to the shallow vadose zone, but extend to deeper portions of the vadose zone as well.

The lateral ~~spread~~distribution of the 41 vadose zone wells with stable or declining water levels reaches all ~~corners~~areas of the HELSTF Site, as follows (refer to Figure 4.3-~~9~~10 for well locations):

- Southern extent ~~reaching~~ to HMW-23, which is west of SWMU 146 (STP Dry Pond);

- Western extent ~~reaching~~ to HMW-43, which is located within SWMU 141 (Equipment Storage Area);

- Northern extent ~~reaching~~to DRW-05, which is approximately 50 feet northeast of SWMU 154 (Systemic D~~d~~iesel Spill Site); and

- Eastern extent ~~reaching~~to HWM-33, which is approximately 157 feet southwest of SWMU 38 (~~Former Construction~~HELSTF Landfill).

~~As illustrated above,~~T ~~t~~he observed effects of reduced infiltration vary laterally and vertically across the site. The variability observed in response to reduced site activity and reduced infiltration rates ~~imply a high degree o~~is a result of the ~~f~~-geologic heterogeneity ~~exists within the aquifer~~at the site.

4.3.5.2.2 Stable Isotopes and Mixing Analysis

To further investigate the infiltration rate and recharge rate to the Regional Aquifer, aqueous samples were collected from the vadose zone and the Regional Aquifer for a stable isotope study. Differences in relative ratios of hydrogen and oxygen isotopes

(D/H and $^{18}O/^{16}O$ ~~and D/H~~) were used to assess the ratio of vadose zone water mixing with groundwater in the Regional Aquifer (Appendix C-3).

A total of 23 samples were collected, including 2 samples from the HELSTF water source, 12 samples from the vadose zone, ~~2~~ 4 samples from the Regional Aquifer at the upgradient portion of the HELSTF, and 5 samples from the downgradient portion of the Regional Aquifer. Sampling locations are shown on Figure 1 in Appendix C-3. All samples were analyzed for hydrogen and oxygen isotopes. The isotopic signature of samples collected in the downgradient portion of the Regional Aquifer was heavier compared to the upgradient regional groundwater samples (Appendix C-3, Figure 2). Samples from the vadose zone had more varied isotopic composition but were generally heavier than both of the regional groundwater sample groups suggesting that mixing of vadose zone water with upgradient regional groundwater results in the isotopic composition of the downgradient groundwater samples. The mixing ratio, expressed as the flow of vertically infiltrating vadose zone water to the lateral flow of regional groundwater was calculated to approximately 0.24 to 0.42 (refer to Figure 3, Appendix C-3). Based on calculated groundwater flow beneath the HELSTF using measured aquifer properties (3.3 gpm), the rate of recharge to the Regional Aquifer was estimated to be approximately 0.8 to 1. 4 gpm.

The stable isotope study~~, thus,~~ results indicate~~s~~ a smaller amount of current infiltration into the Regional Aquifer compared to the water balance analysis based on information from 1995 to 1996 and 2004 to 2007. The water balance analysis allowed for an estimate of water infiltrating to the shallow subsurface. Some of the water reaching the shallow subsurface would be transported to the surface via capillary forces and lost to evapotranspiration. The lower estimated recharge from the vadose zone to the Regional Aquifer using stable isotopes may in part be due to evaporation of some water leaking from pipes and lagoons. However, based on both analyses, the recharge to the Regional Aquifer is estimated to range between approximately 1 and 5 gpm. A technical memorandum that describes the results of the Stable Isotopes and Mixing Analysis is provided as Appendix C-3.

4.3.5.2.3 Vadose Zone Hydraulic Testing

Several pumping tests have been performed in wells completed in the saturated soil zones beneath the HELSTF. In 1993 (ITC, 1993), a step-drawdown test was performed within the vadose zone at the HELSTF Cleaning Facility Sump (SWMU 142). Based on results of the step-drawdown test, transmissivity of the saturated soils in the immediate vicinity of the tested wells was estimated (using a model that assumes an ideal aquifer

of infinite extent) between 2.41 to 3.48 5 square feet per day (ft^2/day). However, the observed hydraulic response deviated significantly from ideal aquifer behavior. in that boundary conditions were not accounted for, resulting and in nNo drawdown was was being observed in adjacent wells., , indicating the saturated zone exhibits very limited lateral hydraulic connectivity. Therefore, the analysis likely underestimated local hydraulic conductivity values. More generally, it should be recognized that these values and that the estimated transmissivity valuesonly represent near-well conditions and do not represent larger-scale average aquifer permeability.

Additional well testing was performed at the HELSTF in 2009 to further evaluate hydraulic conditions in the saturated soil zone. Criteria used to select appropriate wells for testing included 2006 well redevelopment activities, slug testing data from 1992 and 1994, recent water level data, and facility activities. The objectives of these tests were to measure sustainable water extraction rates, quantify inter-well hydraulic communication, and determine whether boundary conditions are present. Extraction pumping tests were performed at three HELSTF area wells: HMW-38, HMW-40, and HMW-41 (Figure 4.3-910). One extraction pumping test was performed in the gypsiferous/ upper interbedded zone (HMW-40 , screened from 28 to 38 ft bgs) and two were conducted in the deeper interbedded zone (HMW-38, screened from 52 to 62 ft bgs and HMW-41, screened from 49 to 59 ft bgs).

The gypsiferous/upper interbedded zone extraction test was performed at HMW-40 near the former Sanitary Treatment System (SWMU 27) (Figure 4.3-910). Based on current site data, this well was selected as the most viable testing location. because Mmost of the gypsiferous/upper interbedded zone monitoring wells were either dry or water levels in the wells were likely to be condensate or within the constructed well sump. Extraction rates were initiated at 0.95 gpm and water levels decreased rapidly; after 14 minutes of pumping the rate was decreased to approximately 0.5 gpm. Water levels continued to decline and the test was terminated after approximately 24 minutes of pumping (Figure 4.3-10110). Only about 16 gallons of water was extracted over 24 minutes of pumping, resulting in approximately 15 feet of drawdown, and only very minor water level recovery was observed after pumping was terminated. No observation wells responded to pumping at HMW-40. Based on these results, this saturated soil zone has very limited hydraulic connectivity with other saturated soil zones and sustainable yields are very low (likely less than 0.1 gpm).

Another extraction test was conducted at HMW-41, adjacent to HMW-40, but screened in a deeper saturated zone (Figure 4.3-910). Extraction rates were initiated at approximately 0.92 gpm. The water level decreased rapidly and after 25 minutes of

pumping, the rate was decreased to approximately 0.5 gpm. Water levels continued to decline and the test was terminated after approximately 41 minutes of pumping. A total volume of approximately 26 gallons of water was extracted during this test resulting in approximately 15 feet of drawdown. No observational wells responded to pumping at HMW-41. Based on these results, this saturated soil zone has very limited hydraulic connectivity with other saturated soil zones and sustainable yields from this zone are very low (likely less than 0.1 gpm).

A third extraction pumping test was conducted at HMW-38 , located northwest of the Chromium Spill Site (SWMU 143) (Figure 4.3-~~10~~11). Pumping rates were increased step-wise starting at .~~85~~ 0.9 gpm, then increased to approximately 2 gpm and rates were sustainable. The extraction rate was increased to 4 gpm but had to be reduced to 3.5 gpm and once again to approximately 3 gpm~~,~~ due to drawdown and ~~, to 3.5 gpm and once again to approximately 3 gpm~~ to keep the submersible pump from lowering the water level to the pump intake. Water levels did decline such that the water in the well began to vortex and the test was terminated. The total pumping time was approximately 6 hours and 1,085 gallons of water was extracted resulting in a drawdown of approximately 16 feet. The data collected were imported into AQTESOLV for analysis ~~and this solution was used to~~ and data interpret~~ation the data~~. The estimated transmissivity is approximately 25 ft^2/day; based on the boring log for HMW-38, ~~information~~ the saturated thickness is approximately 5 feet and the corresponding value for hydraulic conductivity is approximately 5 ft/day. Other wells that may have responded to pumping at HMW-38 are HMW-13 and HMW-37; however, the data collected from these wells are not readily discernable from background water level fluctuations and are not a definitive result of water extraction at HMW-38.

In summary, the results of these tests clearly confirm that saturated soil zones in the vadose zone have complex but very limited hydraulic interconnection and that in general they cannot sustain extraction rates that would make their use as supply wells efficient or practical.

4.3.5.3 *Groundwater Use*

Potable water is largely confined to alluvial fans along the mountain ranges in the basin. Water quality decreases as it moves away from the mountain fronts and mixes with slower moving brackish water at the basin interior. The Regional Aquifer beneath the HELSTF, which is located within the Alkali Flats, does not produce potable water. ~~It~~The HELSTF receives water from three supply wells (MAR-1, MAR-2, and MAR-3) located 7 miles to the west along Range Road 7.

The closest pumping well is the THEL-01 well, located approximately 2.6 miles ~~to the~~ southwest of the HELSTF. Because of the naturally high TDS, this well is used only for fire suppression at the Tactical High Energy Laser (THEL) site. The THEL-01 water well is not located downgradient from the HELSTF and would not likely be affected by operations at the HELSTF. There are no known production wells downgradient of the HELSTF; further, no future production or supply wells are expected to be installed downgradient of the HELSTF due to the very high natural TDS (greater than 10,000 mg/L).

As noted earlier, shallow vadose zone water in the HELSTF area is also of poor quality and meaningful extraction rates cannot be achieved from these units; therefore, there is no current or expected future use of the existing vadose zone water.

4.3.6 Geochemistry of Naturally Occurring Minerals

The Tularosa Basin is rich in naturally occurring soluble minerals that contain many inorganic compounds. As further discussed in Section 6 (RCRA Facility Investigation Discussion, page 97), a number of constituents that are associated with the natural mineralogy of the basin were detected in soil and groundwater during the three phases of the RFI. Several of them were detected above regulatory standards. Due to these conditions, a comprehensive review of professional publications was conducted in order to identify those inorganic compounds that are native to the sediments and groundwater within the Tularosa Basin extending beneath the HELSTF. Information obtained during this review was used ~~to~~as a basis for distinguishing ~~screen inorganic compounds in order to identify~~ those inorganic compounds ~~s~~ that are likely associated with wastes managed within the RFI SWMUs. from those that are naturally occurring. ~~The basis for distinguishing the waste-derived presence of these materials from their natural occurrence.~~ COPCs are discussed in Section 6.1 (COPC Selection Process for Site Characterization, page 97). A summary of information obtained during the review of professional publications is provided in the following paragraphs.

As part of the geologic process for the Tularosa Basin, the Precambrian rocks in central and south-central New Mexico, including the central San Andres Mountains immediately west of the HELSTF, were exposed during formation of the Tularosa Basin and likely contributed a significant volume of sediment and associated geochemical signatures to Cenozoic deposits in the basin (Figure 4.3-2). The Precambrian rocks contain approximately 70 percent granitic plutons and 30 percent metamorphic rocks (Figures 4.3-1 and 4.3-2) (Condie and Budding, 1979). The principal metamorphic rock types contain 40 percent phyllite and quartz-mica schist,

30 percent quartzite and arkosite, 15 percent mafic (rich in magnesium and iron) meta-igneous rocks, and 5 percent gneisses (Condie and Budding, 1979). The mechanical and chemical weathering of these rocks is associated with the occurrence of selected inorganic compounds and metals within the Tularosa Basin deposits.

Large contributions of dissolved evaporite components are transported to the Regional Aquifer from the basin-bounding mountain ranges. Hibbs et al. (1997) identified distinct hydrochemical groups from mountain and mountain front water quality samples from the Regional Aquifer. Along the Sacramento Mountains, groundwater with greater than 1,000 mg/L TDS generally have calcium chloride sulfate signatures and groundwater with less than 1,000 mg/L TDS generally have calcium bicarbonate signatures, indicative of influence by dissolution of limestone and gypsum (Figure 4.3-1). Along the San Andres and Organ Mountains (representative of the HELSTF), calcium bicarbonate and mixed-cation bicarbonate sulfate type groundwater with TDS less than 1,000 mg/L have been observed (Figure 4.3-1). Moving eastward along the basin floor, professional literature suggests that groundwater has increasing sodium-chloride-sulfate and mixed-cation-sulfate-chloride signatures for samples with TDS greater than 10,000 mg/L, which are interpreted to contain a large volume of dissolved evaporite minerals. Druhan et al. (2008) reported that the Tularosa Basin contributes a chloride/sulfate (Cl/SO_4) ratio of 0.4 to the Hueco Bolson aquifer via basin outflow, a geochemical signature attributed largely to dissolution of the Permian gypsum sulfate (Yeso Formation). Naturally occurring concentrations of both sulfate and chloride exceed regulatory standards in nearly all native samples.

Water quality data from the Mound Spring complex in the northern Tularosa Basin also provide insight into the elements that may be present in the basin and samples from the area are used below as points of reference in that regard. Water samples collected from the springs indicate calcium-sodium-chloride-sulfate type water (dominant ions) (Myers and Naus, 2004). Isotopic data for a water sample collected from Mound Springs by the USGS in 1982 indicates an age of approximately 19,600 years (Cruz, 1983). Although the reported age does not take into account that the aquifer system is not a closed system, surface water in the Mound Springs complex is likely sustained by shallow regional groundwater discharge from the northern portion of the Tularosa aquifer.

In addition, results of water quality samples collected by the USGS from the Regional Aquifer from 1982 to 1990 ~~in the vicinity~~ immediately upgradient of the HELSTF and elsewhere within the basin are discussed in the context of ~~background~~ naturally occurring concentrations of inorganic metals (Section 4.3.5.1, page 33) (Basabilvaso et

al., 1994; Cruz, 1983). In particular, two of the deep off-site test wells that were sampled (HELSTF-2 and HELSTF-3) are located approximately 0.6 mile northwest of the HELSTF and are both screened in the Regional Aquifer from approximately 80 to 500 ft bgs.

4.3.6.1 *Soluble Minerals and their Elements*

The primary sources of soluble minerals in the Tularosa Basin are gypsiferous evaporites that are ubiquitous in the basin sediments. Evaporites are minerals that form when water evaporates leaving the dissolved solids as a precipitate. Their source is the dissolution and mechanical weathering of the basin-bounding mountains so they may be expected to contain the same elements. When large volumes of water evaporate, the deposits that form can be of significant thickness, as in the Tularosa Basin. Within the Tularosa Basin, gypsum or selenite ($CaSO_4$) and limestone (calcite, $CaCO_3$) are the most abundant evaporite minerals along with unidentified iron-bearing phases (Almendinger and Titus, 1973). In order to assess which elements are naturally occurring, the mineralogical composition of evaporite deposits from outside the Tularosa Basin is used as reference. In addition to calcium sulfates and calcium carbonates, evaporite minerals commonly include halides (halite, NaCl, fluorite, CaF_2), nitrates (soda niter, $NaNO_3$), and occasionally borates (borax, $Na_2B_4O_7$, $10H_2O$) (Ikeya, 1993). Additionally, a number of elements can readily substitute for the more common ones if present in the source material.

Based on the composition of common evaporites, a number of soluble elements are likely to occur naturally in the sediments and groundwater of the Tularosa Basin. Those elements are described below and distinguished from other sources by defining two categories:

- Naturally occurring elements that can be explained by simple dissolution of the minerals in the soil matrix; and
- Naturally occurring elements that may or may not be soluble under normal HELSTF conditions but experience increased solubility under altered redox conditions when soil is wetted or organic carbon is introduced to a wet system.

The naturally occurring elements are listed below.

Strontium

Strontium and selenium are strongly associated with gypsum and anhydrite because of their chemical similarities to calcium and sulfate, respectively. Strontium commonly occurs in nature, the fifteenth most abundant element on earth, and is found chiefly as the sulfate mineral celesite ($SrSO_4$), common in gypsiferous sediments, and as carbonate strontianite ($SrCO_3$) (Playá and Rosell, 2005). Strontium has a similar electron configuration to calcium, but is slightly larger due its greater atomic weight and can substitute for calcium ions in gypsum.

Trace element analyses of Precambrian granitic rocks in the region indicate mean strontium compositions of 45 to 250 ppm. Trace element analyses of Precambrian mafic igneous and phyllite and mica schist in the region indicate mean strontium compositions of 70 to 200 ppm (Condie and Brookins, 1980).

Reported dissolved strontium concentrations range up to 10,000 micrograms per liter (µg/L) and total strontium concentrations up to 11,000 µg/L in shallow regional groundwater discharged at the Mound Springs complex (Cruz, 1983; Ortiz and Lang, 1997). Dissolved strontium at Malpais Springs ranges up to 9,800 µg/L (Cruz, 1983). Immediately west of the HELSTF, dissolved strontium concentrations in regional groundwater collected at HELSTF-2 and HELSTF-3 range up to 14,000 µg/L (Basabilvaso et al., 1994).

At the HELSTF, maximum concentrations of total and dissolved strontium in vadose zone water and the Regional Aquifer are similar in magnitude to reported ~~background~~ naturally occurring concentrations (as indicated through the literature review of professional publications) detected during historical Regional Aquifer sampling within the Tularosa Basin. In addition, the ubiquitous detection of strontium at the HELSTF, the natural occurrence of strontium within the geologic source materials along the basin margins, and the likely dissolution of strontium-containing gypsum and celestite indicate that aqueous strontium concentrations encountered at the HELSTF are naturally occurring.

Selenium

Selenium is rare, composing approximately 90 parts per billion of the Earth's crust. It is occasionally found uncombined, accompanying native sulfur, but is more often found in

combination with heavy metals (copper, mercury, lead, or silver) in a few minerals. Selenium occurs naturally in a number of inorganic forms, including selenide (commonly found in sulfide ores, such as those of copper, silver, and lead) and selenite. In soils under oxidizing conditions, the most stable form of selenium is as selenate (SeO_4^{-2}), which is leached into rivers very easily by runoff.

Selenium is strongly associated with gypsum and anhydrite because of its chemical similarity to the sulfate ion (SO_4^{-2}), which can substitute for sulfate in gypsum. In samples collected from monitoring wells at the HELSTF, the selenium and sulfate concentrations are correlated such that the selenium concentration increases with increasing sulfate concentration. This suggests that the source of selenium is the same as sulfate. Thus, selenium is naturally occurring as a result of dissolution of selenium bearing gypsum. At most monitoring well locations at the HELSTF, selenium occurs at naturally elevated concentrations.

Ortiz and Lang (1997) reported dissolved selenium concentrations up to 3.0 µg/L in shallow regional groundwater discharged at the Mound Springs complex. Basabilvaso et al. (1994) reported dissolved selenium concentrations in regional groundwater up to 12 µg/L in water samples collected from HELSTF-2 and HELSTF-3. The maximum detected concentration of selenium in vadose zone water at the HELSTF (899 µg/L) is slightly greater than the maximum detected concentration in the Regional Aquifer at the HELSTF. The leaching of selenium at naturally elevated concentrations from saturated evaporites may account for its occurrence in the vadose zone.

Boron

Boron is widely distributed in low concentrations throughout nature in the form of various inorganic borates. It constitutes about 10 milligrams per kilogram (mg/kg) of the Earth's crust, ranging from 5 mg/kg in basalts to 100 mg/kg in shales (Woods, 1994). Economic deposits of borate minerals are rare and are usually found in arid desert regions with a geological history of volcanic and/or hydrothermal activity (e.g., Rio Grande Rift) (Mellor, 1980). The most abundant boron mineral is tourmaline, an aluminium borosilicate that contains about 3.1 percent boron, which commonly occurs in granitic pegmatites (e.g., Precambrian granitic plutons that border the Tularosa Basin) (Muetterties, 1967). Borax, also known as sodium borate or sodium tetraborate, can be found in evaporite deposits produced by the repeated evaporation of seasonal lakes. It occurs in several forms that differ in their content of water of crystallization: anhydrous sodium borate ($Na_2B_4O_7$), sodium borate pentahydrate ($Na_2B_4O_7 \cdot 5H_2O$), and sodium borate decahydrate ($Na_2B_4O_7 \cdot 10H_2O$). Within the Basin and Range

Province in Arizona, boron is often encountered in deeper alluvium zones of the basin and is co-located with gypsum (University of Arizona 2009). Because the Tularosa Basin makes up a part of the Basin and Range Province, similar geochemistry of the evaporites is expected. Thus, the elevated aqueous boron concentrations encountered at the HELSTF are likely, at least in part, due to dissolution of soluble boron minerals.

Total and dissolved boron concentrations range up to 240 µg/L in shallow regional groundwater discharged at the Mound Springs complex (Cruz, 1983; Ortiz and Lang, 1997). Dissolved boron ranges up to 220 µg/L at Malpais Springs and up to 130 µg/L in Regional Aquifer samples from the Lucero Ranch well (Cruz, 1983). Immediately west of the HELSTF, dissolved boron concentrations in regional groundwater collected at HELSTF-2 and HELSTF-3 range up to 14,000 µg/L (Basabilvaso et al., 1994).

Given the strong correlation of boron-bearing minerals with evaporite deposits, the ubiquitous detection at the HELSTF, and elevated ~~background~~ concentrations detected in Regional Aquifer monitoring wells, the boron detected in groundwater at the HELSTF indicate that it is naturally occurring.

Fluoride

Fluorite (CaF_2) occurs in evaporite deposits and is often associated with precipitates from hydrothermal fluids (Warren, 2006). Cruz (1983) reported ~~background~~ naturally occurring concentrations of fluoride ~~concentrations~~ in the Regional Aquifer of 0.5 mg/L at the Lucero Ranch well, 1.2 mg/L at the Mound Springs complex, and 1.3 mg/L at Malpais Springs. Meyers et al. (2005) reported dissolved fluoride concentrations up to 1.4 mg/L for regional groundwater discharged at Mound Springs. Basabilvaso et al. (1994) reported fluoride concentrations up to 5.0 ~~1.8~~ mg/L for historical sampling of the Regional Aquifer from Background Wells HELSTF-2 and HELSTF-3 and on-site Well MAR-CW. Much like sulfate and chloride, fluoride occurs naturally in the evaporite deposits at the site and it is clear that the dissolution of those evaporites results in fluoride concentrations that exceed regulatory standards. This information, along with the high frequency of detection of fluoride throughout the HELSTF, indicates that it is naturally occurring.

Lithium

Due to its high reactivity, lithium does not occur in elemental form under natural conditions and is always bound with one or more other elements or compounds.

Estimates for crustal content range from 20 to 70 ppm by weight (Kamienski et al., 2004). Lithium forms a minor component of igneous rocks, with the largest concentrations in granites. Granitic pegmatites, such as those found in Precambrian rocks along the margins of the Tularosa Basin, provide the greatest abundance of lithium-bearing minerals, with spodumene and petalite being the most commercially viable mineral sources for the element. Lithium is a minor chemical element that is very soluble and tends to concentrate in many natural brines (salty solutions) in evaporative systems and clays (Middleton et al., 2003). Elevated lithium concentrations are generally expected in saline systems.

Ortiz and Lang (1997) reported dissolved lithium concentrations between 43 and 66 µg/L and total lithium concentrations between 40 and 50 µg/L in shallow regional groundwater discharged at the Mound Springs complex. Basabilvaso et al. (1994) reported dissolved lithium concentrations in regional groundwater up to 3,200 µg/L at HELSTF-2 and HELSTF-3.

Lithium concentrations in vadose zone water and the Regional Aquifer are similar to concentrations detected in historical water quality sampling outside the HELSTF. The natural occurrence of lithium in brines and clays, both associated with the Tularosa Basin, coupled with a high frequency of detection (approximately 92 percent), indicate that lithium is naturally occurring.

Aluminum

Aluminum occurs naturally in igneous rocks chiefly as aluminosilicates in feldspars, feldspathoids, and micas, as well as in soils derived from these rock types such as clay, and in further weathering as bauxite and iron-rich laterite. Geochemical analyses of Precambrian granitic rocks in the region indicate a mean composition of 12.9 to 14.7 weight percent aluminum oxide (Al_2O_3) (Condie and Brookins, 1980). Geochemical analyses of Precambrian mafic igneous and phyllite and mica schist in the region indicate a similar range in mean composition of 12.5 to 17.5 weight percent aluminum oxide (Condie and Brookins, 1980).

Dissolved aluminum concentrations were reported up to 30 µg/L and total aluminum concentrations up to 1,900 µg/L in shallow regional groundwater discharged at the Mound Springs complex (Cruz, 1983; Ortiz and Lang, 1997). Dissolved aluminum at Malpais Springs ranges up to 20 µg/L (Cruz, 1983). Immediately west of the HELSTF, dissolved aluminum concentrations in regional groundwater were reported up to 530 µg/L at HELSTF-2 and HELSTF-3 (Basabilvaso et al., 1994).

Barium

Barium is a relatively abundant element that combines with other elements in soils, rocks, and minerals. It ranks seventh in abundance among the minor elements and constitutes about 0.04 percent of the earth's crust (Schroeder, 1970; Reeves, 1979). The two most prevalent naturally occurring compounds of barium are barite (barium sulfate) and witherite (barium carbonate). Barite occurs in beds or masses in limestone, dolomite, shales (all three rock types present along the margins of the Tularosa Basin), and other sedimentary formations and as residual nodules resulting from the weathering of barite-bearing dolomite or limestone. Barium is ubiquitous in soils, being found at concentrations ranging from 100 to 3,000 micrograms per gram (Robinson et al., 1950; Schroeder, 1970). Brooks (1978) estimated an average soil concentration of 500 mg/kg. Barium can be transported into groundwater aquifers through the leaching and eroding of barium from sedimentary rocks. The concentration of barium present in the groundwater is related to the hardness of the water because barium is always present with calcium (Kopp & Kroner, 1968).

Trace element analyses of Precambrian granitic rocks in the region indicate mean barium compositions of 575 to 840 ppm. Trace element analyses of Precambrian mafic igneous and phyllite and mica schist in the region indicate mean barium compositions of 200 to 600 ppm (Condie and Brookins, 1980).

Lansford et al. (1976) reported an average barium concentration of 440 µg/L in regional groundwater based on water quality sampling of 17 wells in the Alamogordo-Tularosa area. Ortiz and Lang (1997) reported dissolved barium concentrations between 10 and 19 µg/L in shallow regional groundwater discharged at the Mound Springs complex. Basabilvaso et al. (1994) reported dissolved barium concentrations of 100 µg/L at HELSTF-2 and HELSTF-3 immediately west of the HELSTF.

Detected concentrations of barium in vadose zone water are within the range of detected ~~background~~ concentrations in the Regional Aquifer that are considered as naturally occurring as indicated through the literature review. Given the natural occurrence in nearby geologic source materials and ~~in background~~ water quality ~~sampling~~ data collected outside of the HELSTF, the detected barium concentrations are likely naturally occurring at the HELSTF.

Vanadium

Vanadium is a typical rare element, present in the Earth's crust at concentrations of around 15 mg/kg, which is roughly in the same proportion as chromium, strontium, and zirconium. It is considerably more widespread than copper, lead, zinc, and other minor elements. Some 70 vanadium minerals are known, of which 40 are vanadates. The main vanadium minerals are vanadinite, descloizite, cuprodescloizite, carnotite, roscoelite, and patronite. Metallic vanadium does not occur in nature and the richer minerals rarely occur in large deposits. Vanadium compounds are present in fossil fuels (oil, coal, and shale), and some oilfields have a high vanadium content (National Academy of Sciences [NAS], 1974). The vanadium content of soils ranges from 3 to 310 mg/kg, with the highest concentrations found in shales and clays (Waters, 1977).

Reported analyses for vanadium concentrations in geologic source materials along the margins of the Tularosa Basin and in the Regional Aquifer were unavailable. However, vanadium was recently detected in background Regional Aquifer Well HMW-08 at concentrations up to 26 µg/L.

Vanadium appears to be naturally occurring in the Regional Aquifer based on historical water quality sampling at Background Well HMW-08. Detectable levels of vanadium are also ubiquitous in vadose zone water at the HELSTF with a frequency of detection of approximately 87 percent. The maximum detected concentration in the Regional Aquifer at the HELSTF is slightly greater than the maximum detected concentration in vadose zone water. The vanadium concentrations at the HELSTF are likely to be naturally occurring.

4.3.6.2 *Naturally Occurring Redox-Affected Elements*

The redox conditions at the HELSTF are normally oxidizing; however, the biological degradation of organic material released at the HELSTF Systemic Diesel Spill (SWMU 154) and former Sanitary Treatment System (SWMU~~s~~ 27~~, 28, 29, and 30~~) created localized zones of reducing conditions where elements susceptible to redox-enhanced dissolution could have been introduced to the dissolved phase or elevated in dissolved concentration. Several naturally occurring elements at the HELSTF are sensitive to changes in redox conditions and become more soluble in water when the geochemical environment becomes reducing.

Iron, manganese, and arsenic are the primary metals that appear to have experienced enhanced solubility as a result of localized reducing conditions. Nickel and cobalt also occur naturally in soils in the HELSTF area and have the potential for enhanced solubility. Similarly, ~~C~~copper and~~,~~ cadmium~~, and nickel also~~ have the potential for enhanced solubility although they are not naturally occurring.~~and nickel has been included in this category because it occurs naturally in soils in the HELSTF.~~

The mechanism for explaining redox-enhanced dissolution is as follows: Under oxidizing conditions, both iron and manganese are present as oxides or hydroxides, but dissolve under mildly reducing conditions when their oxides or hydroxides become unstable to form ferrous iron [Fe(II)] and manganous [Mn(II)] ions.

Both manganese and particularly iron hydroxides have active surfaces that react with inorganic ions in the surrounding water. Both redox forms of arsenic [As(III) and As(V)] sorb to iron and manganese hydroxides and the most prevalent form of arsenic in oxidizing aquifers is complexed to surfaces or incorporated into iron hydroxides (Dzombak and Morel, 1990). This also can occur for cadmium, copper, and nickel. When the iron and manganese oxides and hydroxides begin to become unstable under reducing conditions, the arsenic that is both sorbed to their surfaces and incorporated into them is released to the dissolved phase. Consequently, under mildly reducing conditions, the dissolved concentrations of iron, manganese, arsenic, and nickel increase in groundwater.

Iron

Geochemical analyses of Precambrian granitic rocks in the region indicate a mean composition of 1.35 to 4.93 weight percent iron oxide (Fe_2O_3) (Condie and Brookins, 1980). Geochemical analyses of Precambrian mafic igneous and phyllite and mica schist in the region indicate a similar range in mean composition of 7.2 to 13.2 weight percent iron oxide (Condie and Brookins, 1980).

Dissolved iron concentrations range up to 120 µg/L and total iron concentrations up to 6,000 µg/L in shallow regional groundwater discharged at the Mound Springs complex (Cruz, 1983; Ortiz and Lang, 1997). Dissolved iron concentrations range up to 50 µg/L at Malpais Springs and up to 6.0 µg/L in Regional Aquifer samples from the Lucero Ranch well (Cruz, 1983). Immediately west of the HELSTF, dissolved iron concentrations in regional groundwater were reported up to 1,100 µg/L in water samples collected from HELSTF-2 and HELSTF-3 (Basabilvaso et al., 1994). These data indicate that iron detections can be attributed to a natural occurrence.

Manganese

Manganese is widely distributed in nature, but does not occur in a pure elemental form. The most abundant compounds are oxides (e.g., pyrolusite, brannite, manganite, and hausmannite), sulfides (e.g., hauserite), carbonates (e.g., manganesespar), and silicates (e.g., tephroite, knebelite, and rhodamite). It also occurs in most iron ores in concentrations ranging from 50,000 to 350,000 mg/kg. Manganese concentrations in igneous rock may range from about 400 mg/kg in low-calcium granitic rock to 1,600 mg/kg in ultrabasic rock and sedimentary rocks (NAS-National Research Council, 1973). Deep sea sediments contain concentrations of about 1,000 mg/kg (Turekian and Wedepohl, 1961). In soil, manganese concentrations depend primarily on the geothermal characteristics of the soil, but also on the environmental transformation of natural manganese compounds, the activity of soil microorganisms, and the uptake by plants.

Dissolved manganese concentrations are reported to range up to 20 µg/L and total manganese concentrations up to 40 µg/L in shallow regional groundwater discharged at the Mound Springs complex (Cruz, 1983; Ortiz and Lang, 1997). Dissolved manganese concentrations range up to 8.0 µg/L in the Regional Aquifer at the Lucero Ranch well and up to 20 µg/L at Malpais Springs (Cruz, 1983). Immediately west of the HELSTF, dissolved manganese concentrations in regional groundwater collected at HELSTF-2 and HELSTF-3 range up to 1,100 µg/L (Basabilvaso et al., 1994). Therefore, ~~background~~ water quality data collected at some locations outside of the HELSTF and within the Tularosa Basin indicated levels of manganese that exceed screening levels ~~at some locations outside of the HELSTF within the Tularosa Basin~~.

The maximum concentration of dissolved manganese in vadose zone water at the HELSTF is in the range of reported ~~historical background~~ levels representing natural occurrence in the Regional Aquifer immediately northwest of the HELSTF (Cruz, 1983). Though the maximum concentration of both dissolved and total manganese in vadose zone water is one order of magnitude greater than the maximum concentration in the Regional Aquifer at the HELSTF, exceedances in vadose zone water and the Regional Aquifer occur in the vicinity of the HELSTF Systemic Diesel Spill. Biological activities related to the diesel spill likely created localized zones of reducing conditions that increased manganese concentrations in vadose zone water. ~~(see subsequent discussion on redox-affected elements).~~ Despite a low frequency of detection (approximately 24 percent), the ~~probable~~ manganese concentrations at the HELSTF appear to be the result of solubilization due to low redox conditions.

Arsenic

Welch et al. (1988) found that high concentrations of arsenic throughout the western United States are associated with four geochemical environments, one of which includes alluvial and lacustrine deposits, particularly in semiarid areas where sediment is derived from volcanic rocks. Volcanic deposits along the margins of the Tularosa Basin include the Tertiary Malpais Lava Flow (Carrizozo Volcanic Field) and thousands of feet of Tertiary volcanics associated with the Rio Grande Rift (e.g., Bear Springs, Mimbres Peak, Bell Top, and Rubio Peak). The arsenate anion (AsO_4^{3-}) substitutes for sulfate (SO_4^{2-}) in gypsum, anhydrite, and calcite, which is another mechanism likely responsible for elevated concentrations of naturally occurring arsenic in the evaporate deposits at the HELSTF. Incorporation of both arsenate and arsenite (AsO_3) into solid mineral phases (e.g., iron oxides) is the predominant control on arsenic solubility in industrial and mining sites (Fernandez-Martinez et. al. 2006).

Little data are available regarding arsenic sorption reactions in calcite and gypsum and on the precipitation and dissolution of $Ca_3(AsO_4)_2$. However, arsenic (III) can be adsorbed by calcite and arsenic (V) by gypsum (Roman et al. 2006). Several professional publications suggest that elevated arsenic concentrations in groundwater could result from reactions between iron oxides with adsorbed arsenic and groundwater under reducing conditions (Fujii and Swain, 1995; Welch and Lico, 1998; Welch, 1988). Results of tests conducted by Fernandez-Martinez et al. (2006) indicated a continuum between adsorption and the formation of solid solutions $Ca(SO_4, HAsO_4)$ and $Ca(CO_3, HAsO_3)$. Increases in CO_2 concentrations cause increases in arsenic adsorption in both calcite and gypsum at pH levels between 7 and 10 (Roman et al. 2006). A biologically mediated reaction that can release arsenic from iron oxide, commonly referred to as dissimilatory iron reduction, involves organic carbon and iron oxide (Lovley, 1991). Sources of organic carbon include sedimentary organic matter and anthropogenic organic compounds. Groundwater affected by petroleum products (e.g., Diesel Spill Site) has the potential to dissolve iron oxide. Dissolution of iron oxide, and release of arsenic incorporated into iron minerals, or sorbed onto iron minerals, is likely the primary process responsible for high arsenic concentration in groundwater at the HELSTF.

Elevated arsenic concentrations also appear to be associated with elevated phosphorous and alkalinity (pH > 8), which is consistent with adsorption onto iron oxide as one factor affecting arsenic concentrations. At the HELSTF, alkalinity ranges up to approximately 5,000 mg/L and is ubiquitous. Phosphorus concentrations range up to approximately 6 mg/L at some locations.

Another factor that appears to increase arsenic concentrations in groundwater is evaporative concentration. This process is particularly important in closed hydrologic basins of the semiarid western United States where evaporation rates exceed precipitation. For example, in the Carson Desert and southern San Joaquin Valley, evaporation appears to be a contributing factor in producing high arsenic concentrations (Fujii and Swain, 1995; Welch and Lico, 1998). Because arsenic is not incorporated in most evaporate minerals, the concentrations in groundwater associated with these minerals can have high arsenic concentrations (Levy et al., 1999).

Basabilvaso et al. (1994) reported dissolved arsenic concentrations up to 52 µg/L at upgradient Wells HELSTF-2 and HELSTF-3 during USGS site investigations. Cruz (1983) reported dissolved arsenic concentrations of 1.0 µg/L in water samples from the Malpais Springs.

Arsenic occurs naturally at low levels (up to 52 µg/L) at locations outside of the HELSTF within the Tularosa Basin. The fact that arsenic concentrations are ~~Higher concentrations (by one~~an ~~order of magnitude)~~ higher ~~in~~ the Regional Aquifer beneath the HELSTF than those ~~are~~ reported by the USGS for historical background levels, arsenic has low frequency of detection (approximately 15 percent) in the Regional Aquifer at the HELSTF, and maximum total and dissolved arsenic concentrations in the vadose zone ~~that~~ are slightly greater than maximum concentrations in the Regional Aquifer would ~~otherwise~~ typically indicate an anthropogenic source for arsenic at the HELSTF. However, all historical exceedances of arsenic in vadose zone water and regional groundwater are spatially located within the areas impacted by historical releases from the Systemic Diesel Spill Site and former Sanitary Treatment System. Biological activities related to the diesel spill or discharge of sewage water likely resulted in localized zones of reducing conditions that increased arsenic concentrations in vadose zone water. In addition, detections of arsenic outside the zone of reducing conditions are below HELSTF-wide background screening levels and are similar to background levels detected at HELSTF-02 and HELSTF-03. Therefore, arsenic concentrations at the HELSTF appear to be naturally occurring.~~Arsenic (AsO_4) substitutes for sulfate (SO_4) in gypsum, anhydrite, and calcite, which controls the solubility in industrial and mining sites (Fernandez-Martinez et. al. 2006). Little data are available regarding arsenic sorption reactions in calcite and gypsum and on the precipitation and dissolution of $Ca_3(AsO_4)$. However, arsenic (III) can be adsorbed by calcite and arsenic (V) by gypsum (Roman et al. 2006). Welch et al. (1988) suggested that elevated arsenic concentrations in groundwater could result from reactions between iron oxides with adsorbed arsenic and groundwater under reducing conditions. Results of tests conducted by Fernandez-Martinez et al. (2006) indicated a~~

~~continuum between adsorption and the formation of solid solutions $Ca(SO_4, HAsO_4)$ and $Ca(CO_3, HAsO_3)$. Increases in CO_2 concentrations cause increases in arsenic adsorption in both calcite and gypsum at pH levels between 7 and 10 (Roman et al. 2006). Welch et al. (1988) found that high concentrations of arsenic throughout the western United States are associated with four geochemical environments, one of which includes alluvial and lacustrine deposits, particularly in semiarid areas where sediment is derived from volcanic rocks. Volcanic deposits along the margins of the Tularosa Basin include the Tertiary Malpais Lava Flow (Carrizozo Volcanic Field) and thousands of feet of Tertiary volcanics associated with the Rio Grande Rift (e.g., Bear Springs, Mimbres Peak, Bell Top, and Rubio Peak).~~

~~Basabilvaso et al. (1994) reported dissolved arsenic concentrations up to 52 µg/L at upgradient Wells HELSTF-2 and HELSTF-3 during USGS site investigations. Cruz (1983) reported dissolved arsenic concentrations of 1.0 µg/L in water samples from the Malpais Springs.~~

~~Arsenic occurs naturally at low levels (up to 52 µg/L) at locations outside of the HELSTF within the Tularosa Basin. Higher concentrations (by one order of magnitude) than are reported by the USGS for historical background levels, low frequency of detection (approximately 15 percent), and maximum total and dissolved arsenic concentrations in the vadose zone that are slightly greater than maximum concentrations in the Regional Aquifer would otherwise indicate an anthropogenic source for arsenic at the HELSTF. However, all historical exceedances of arsenic in vadose zone water and regional groundwater are spatially located within the Systemic Diesel Spill and Sanitary Treatment System. Biological activities related to the diesel spill or discharge of sewage water likely resulted in localized zones of reducing conditions that increased arsenic concentrations in vadose zone water. In addition, detections of arsenic outside the zone of reducing conditions are below HELSTF-wide background screening levels and are similar to background levels detected at HELSTF-02 and HELSTF-03. Therefore, arsenic concentrations at the HELSTF appear to be naturally occurring.~~

Cobalt

Cobalt (II) is the stable valence state in water under most geochemical conditions, and it will generally behave like other +2 ions. Under oxidizing and moderately reducing conditions, the uncomplexed ion Co^{2+} is the dominant cobalt aqueous species at pH values less than 9.5. Under very reducing conditions in the presence of dissolved

sulfide, Co(II) bisulfide species, such as $Co(HS)_2^0$ (aq), likely dominate the aqueous speciation.

The sorption of cobalt in sediments and soils is closely linked to its oxidation state, and is largely controlled by the presence of iron and manganese oxides and clay minerals. In the absence of organic complexants, cobalt is moderately-to-highly adsorbed on minerals, and partition coefficient (K_d) values for cobalt commonly reported in the literature range from 10^3 to 10^5 mL/g [e.g., Lowson and Evans (1983), McLaren et al. (1986), Schell et al. (1986), Routson et al. (1987), Serne et al. (1993), Drndarski and Golobo• anin (1995), Fujikawa and Fukui (1997), Barrow and Whelan (1998), Carroll et al. (1999)]. Studies indicate that at high surface loadings, surface-mediated precipitation processes may be responsible for the high sorption (i.e., large K_d values) observed for cobalt on quartz (O'Day et al. 1996), kaolinite (O'Day et al. 1994a,b; Thompson et al. 1999), Al2O3 (Towle et al. 1997), and clays (Chen and Hayes 1999).. The presence of some inorganic ligands, such as cyanide and possibly nitrite, and other dissolved cations, such as the alkali and alkaline earth ions, can decrease cobalt sorption. This decrease in cobalt sorption is typically caused by the formation of anionic cobalt complexes, which do not readily sorb on mineral surfaces at basic pH values.

Cobalt is often found in solid solution with other elements in minerals, and may substitute in the crystal lattice for other metals, such as Fe(III), Fe(II), Mn(III), and others due to their similarity in ionic radii. Fe(III) (hydr)oxides are important sorbents for metals in aqueous systems and are stable under most oxidizing conditions due to the low solubility of Fe(III) under these redox conditions. The Fe(III) (hydr)oxides will be solubilized under reducing conditions, which in turn may mobilize any metals co-precipitated in the Fe(III) oxides. Zachara et al. (2001) studied the fate of cobalt that was released under anoxic conditions at near neutral pH by the bioreduction of synthesized goethite. Zachara et al. (2001) determined that the Co(III) was mobilized and reduced to Co(II) as a result of the bacterial iron reduction of cobalt-substituted goethite. The concentration of dissolved cobalt increased, and thus its mobility in the environment increased, as a result of the bioreduction process.

Elemental concentrations of 884 dry stream sediment samples were determined by neutron activation analysis from samples collected as part of a geochemical survey in the northern San Andreas Mountains and the Oscura Mountains that border the northwestern margin of the Tularosa Basin (LaDelfe, 1981). Analyses indicate d cobalt concentrations rang ~~e~~ing up to 67.1 parts per million (ppm) were detected in nearly all samples.

Cobalt has been detected at ten monitoring wells in the vadose zone (DRW-01, DRW-02, DRW-03, DRW-04, DRW-12, DRW-13, HMW-11, HMW-36, HMW-37 and HMW-38) and at two monitoring wells in the Regional Aquifer (DRW-16 and HMW-34). The highest concentration was detected at Regional Aquifer monitoring well HMW-34 (287 µg/L, March 2005) where the concentration of total cobalt exceeded the EPA Tapwater screening level of 11 µg/L. However, the results for two sampling events prior to the detection of this maximum concentration indicated that cobalt levels were below laboratory reporting limits, as did eight sampling events immediately after the maximum concentration was detected. Therefore, the value is a statistical outlier and not indicative of the Regional Aquifer conditions. Excluding the exceedance detected at HMW-34 in 2005 (287 ug/L), the only other exceedance of the tapwater standard for cobalt was detected at DRW-16 at a concentration of 13 ug/L (September 2006). All other sample results reported since 2004 indicate levels less than the applicable groundwater standard of 11 ug/L.

Cobalt occurs naturally at high levels (e.g., 67 ppm) in soil samples at locations outside of the HELSTF along the margins of the Tularosa Basin. Historical exceedances (>11 µg/L) of cobalt in vadose zone water are spatially located within the Systemic Diesel Spill Site and at three wells located within 200 feet to the southeast (DRW-12, DRW-13 and HWM-38). One hundred percent of samples where cobalt was 1.5 times or greater than the EPA Tapwater Standard had ~~,~~, iron concentrations ~~was~~ was higher than the average iron value of 1,745 ug/L. " Therefore, biological activity and associated redox changes related to the diesel spill likely resulted in localized zones in the vadose zone water of cobalt liberation from iron (hydr)oxide solids.

Nickel

Trace element analyses of Precambrian granitic rocks in the region indicate mean nickel compositions of 3.0 to 12 ppm. Trace element analyses of Precambrian mafic igneous and phyllite and mica schist in the region indicate mean nickel compositions of 25 to 105 ppm (Condie and Brookins, 1980). Nickel was non-detect in water quality samples collected from background Regional Aquifer Well HMW-08.

Nickel has been detected at three monitoring wells in the vadose zone (DRW-12, DRW-13, and HMW-38) and at one monitoring well in the Regional Aquifer (DRW-16). The highest concentration was detected in the vadose zone at DRW-12 (8,320 µg/L, July 2001), where the total nickel concentration has exceeded the New Mexico groundwater standard since it was first sampled in May 1997. The elevated nickel concentration corresponds to ~~the~~ an elevated total chromium concentration and, ~~;~~ in

July 2001, the highest total chromium concentration detected at the HELSTF (29,000 µg/L) was detected in this well. Nickel has also been detected in two samples collected from DRW-13, which corresponds to elevated total chromium concentrations. One sample (4,880 µg/L, August 2005) from HMW-38 exceeded the New Mexico groundwater standard; however, the maximum concentration in samples collected prior to and after August 2005 was 18 µg/L. The elevated concentration in the Regional Aquifer (DRW-16) correlates with elevated concentrations of total chromium.

Detectable levels of mobilized nickel do not appear to occur naturally in the Regional Aquifer, despite the presence of nickel-bearing minerals in geologic source materials along the basin margins. The maximum detected concentration of nickel in vadose zone water is greater than the maximum detected concentration in the Regional Aquifer by more than 3,000 µg/L. In addition, historical exceedances appear to be delineated in both the vadose zone and Regional Aquifer in the vicinity of the HELSTF Systemic Diesel Spill. Coupled with a low frequency of detection (approximately 25 percent), these observations suggest a natural but redox-affected source for nickel at the HELSTF.

4.3.7 Important Conclusions Drawn from the Environmental Setting and Conceptual Site Model

The environmental setting and resulting CSM for contaminant distribution and transport is complex, particularly with respect to the downward migration of water in the vadose zone. Additionally, several naturally occurring inorganics are associated with the soils and regional groundwater that comprise the Tularosa Basin. This presents site-specific challenges in delineating contaminant impacts spatially~~, and in evaluating the potential risks posed by those contaminants~~. The key components of the environmental setting and resulting CSM that contribute to a framework for addressing these challenges are summarized below for clarity.

- The most significant natural groundwater recharge to the Tularosa Basin occurs along mountain fronts during long duration, winter frontal systems (January to March), where a much higher rainfall ~~gradient~~ in the Sacramento Mountains along the eastern basin margin results in predominantly perennial streams that provide a larger contribution to basin recharge than the western basin margin where only ephemeral streams are present. Natural recharge at the basin interior and near the site is negligible due to very low precipitation and high evapotranspiration rates.

- Water in the vadose zone is primarily the result of both historical discharges and ongoing leaks in the water distribution systems at the HELSTF. ~~It is~~Vadose zone

water heterogeneously distributed both laterally and vertically. As the chemical laser operations were phased out at the HELSTF, there was a reduced use of water and a reduced rate of wastewater generation. A water balance for the HELSTF provides an explanation for the currently stable or decreasing water levels in the vadose zone, where net water flux is generally downward to the Regional Aquifer at a rate that is currently estimated at 1 to 5 gpm.

- Zones of saturated soil in the vadose zone predominantly coincide with narrow, northeast-southwest oriented channel fill sands in the interbedded zone . The channels~~that~~ likely represent zones of high hydraulic conductivity relative to surrounding clay and clayey silts. The spatial distribution of these channel fill sand deposits indicate that complex, cascade-type pattern flow paths likely exist for vadose zone water at the site as a result of vertical and lateral anisotropic conditions. These channel fill sands likely serve as the primary pathways for lateral and vertical migration of site contamination in the vadose zone down to the Regional Aquifer. There is no evidence that lateral migration of water or contaminants over long distances in the vadose zone has occurred.

- The wetted portions of the vadose zone exhibit a complex localized pattern of limited connectivity that suggest it is more appropriate to describe the vadose zone as a system with variable saturation rather than a system containing perched aquifers. Extraction pumping tests conducted in 2009 indicate that these pockets of residual water cannot sustain meaningful yield such that they might realistically be deemed appropriate for use.

- The lack of lateral continuity in vadose zone water results in asymmetric transport and commingling of dissolved contaminants in such a way that specific source identification is often difficult. Three-dimensional contaminant distribution is ~~highly~~ heterogeneous at all scales, which precludes the conventional use of two-dimensional maps that may misrepresent connectivity between affected locations.

- Due to the ~~highly~~ complex nature of flow paths in the vadose zone, the degree of connection observed between vadose zone water and groundwater in the Regional Aquifer varies with location across the HELSTF site and ultimately results in variable mass flux down to the Regional Aquifer.

- Natural geologic processes in the Tularosa Basin have resulted in the occurrence of soluble minerals that contain many inorganic compounds. Weathering of out-cropping rocks provides for the natural occurrence of metals and other inorganic

compounds (chloride, sulfate, and nitrate) for sediments accumulating in the basin. These inorganic compounds include metals such as iron, aluminum, magnesium, and, calcium.

- Large contributions of dissolved evaporite components are transported to the Regional Aquifer from the basin-bounding mountain ranges. Published data for the Regional Aquifer indicate groundwater with greater than 1,000 mg/L TDS generally contain calcium, chloride, and sulfate concentrations that naturally exceed regulatory limits established for groundwater quality.

- The primary sources of soluble minerals in the Tularosa Basin are gypsiferous evaporites that are ubiquitous in the basin sediments. In addition to calcium sulfates and calcium carbonates, evaporite minerals commonly include halides (halite, NaCl; fluorite, CaF_2), nitrates (soda niter, $NaNO_3$), and occasionally borates (borax, $Na_2B_4O_7 \cdot 10H_2O$). Other naturally occurring elements associated with gypsum that were identified during the literature review include strontium, selenium, boron, fluoride, lithium, aluminum, barium, and vanadium.

- Biological degradation of organic material that has been released at the HELSTF Systemic Diesel Spill (SWMU 154) and Sanitary Treatment System (SWMU 27) results in reducing conditions in the subsurface in these areas. Several naturally occurring elements at the HELSTF that include iron, manganese, arsenic, cobalt, copper, cadmium, and nickel are sensitive to changes in redox conditions and become more soluble in water when the geochemical environment becomes reducing.

4.4 Background Study

ARCADIS prepared a Background Characterization Report to: (1) establish the process for determining background levels of metals in soils within the HELSTF area of WSMR; and (2) compare the background data set to the site data set to determine whether or not metals detected in soil samples collected from the SWMUs are site related or are within naturally occurring levels.

Background levels established by the processes described herein were used to differentiate potential health and ecological risks associated with naturally occurring constituents from those that are site-related in risk assessments performed at WSMR.

The Background Characterization Report was prepared following guidance provided in the following documents:

- *Guidance for Comparing Background and Chemical Concentration in Soils for CERCLA Sites* (USEPA, 2002a);
- *Guidance for Environmental Background Analysis* (Naval Facilities Engineering Command [NAVFAC], 2002);
- *Engineering Forum Issue Paper. Determination of Background Concentrations of Inorganics in Soils and Sediments at Hazardous Waste Site* (USEPA, 1995);
- *Role of Background in the CERCLA Cleanup Program* (USEPA, 2002b); and
- *Guidance for Determining Background at VRP Sites* (NMED, 2000).

The Background Characterization Report is presented in Appendix F.

4.4.1 Methodology

The background data set was developed from historical data collected at reference locations within and adjacent to the HELSTF. Analysis of the background data was conducted using statistical techniques in order to identify the natural background levels for each metal. These procedures include:

1. Treating censored data;
2. Determining the probability distribution of the data;
3. Computing summary statistics of measured values;
4. Identifying potential outliers; and
5. Determining background ranges.

The data were evaluated using common statistical software programs including ProUCL 4.0 (summary statistics, distribution tests, and outlier tests) and SigmaPlot (boxplots, univariate scatter plots, probability plots, and bivariate plots if needed).

Detailed descriptions of the statistical application are provided within the Background Characterization Report presented in Appendix F.

4.4.2 Soil Background

The top 10 feet of soil were the focus of the background characterization because those are the soils to which human and ecological receptors could potentially be exposed to site-related constituents through direct contact. Soil samples collected from the top 10 feet throughout the HELSTF area that were identified as background during the Phase I and II RFIs and soil samples collected from a reference area location northwest of the HELSTF area were used to establish background conditions in soil. The reference area was identified as an undisturbed area with the same soil type as found within the HELSTF area. Once the background data set was compiled, non-detects were treated, the distribution of the data set was evaluated, potential outliers were identified and evaluated, and summary statistics were computed. Lastly, a Baseline Soil Level (BSL) for each metal was calculated. Following USEPA guidance, the BSL was determined to be either the one-sided 95 percent confidence interval for the 95th percentile (95/95 upper tolerance level [UTL]) or the maximum detected concentration depending on the size and distribution of the population.

In addition to the comparisons of site data to the BSLs, two additional lines of evidence were used to determine if metals detected in site soil samples were similar or elevated in comparison to background conditions. For metals with maximum detected concentrations greater than the BSL, a geochemical association analysis was performed when possible. The geochemical association analysis method is based upon the understanding that certain groups of metals are closely associated due to the atomic structures and chemical properties. The distribution of trace metals is controlled by the major chemical constituents of soil including aluminum, iron, and calcium. For this site, aluminum and iron are available for the background data set but not for the SWMUs. However, the barium data set for background and SWMUs is comparatively large. The correlation is very strong between aluminum and barium as well as iron and barium suggesting that similar natural variability in site conditions, such as particle size, is likely influencing iron, aluminum, and barium concentrations. However, because aluminum and iron data are largely unavailable for the SWMUs, barium was used as a surrogate to develop the geochemical regressions.

The third line of evidence was a visual examination of the cumulative probability plot, which was developed for both the background data set and the background and site data combined. These plots were examined to identify inflection points or gaps that

would be indicative of more than one population in the data set (i.e., background and "impacted"). Sample points falling above the inflection point were identified as elevated.

The comparison of site data to background was performed and metals were determined to be either similar or elevated in comparison to background conditions based on the three lines of evidence. The results of this evaluation are summarized in Table F-1 of Appendix F.

The results of the Background Characterization Study were used to evaluate soil data collected during all three phases of the RFI that exceeded soil-screening levels. The results of this evaluation are provided under Section 6 (RCRA Facility Investigation Discussion, page 97).

4.5 ~~Previous~~ Environmental Investigations

Summaries of ~~previous~~ investigations that were conducted at the HELSTF are included in this section. More comprehensive summaries of investigation activities that pertain to specific SWMUs are further described under Section 6 (RCRA Facility Investigation Discussion, page 97) of this report.

4.5.1 Environmental Impact Assessment (1975)

WSMR completed an Environmental Impact Assessment (U.S. Army, 1975) for the proposed HELSTF in August 1975 in compliance with the National Environmental Policy Act of 1960. Three existing facilities in WSMR (MAR, NW-30, and LC-37) were evaluated as potential locations for the new complex in order to minimize the impact to the environment and to determine cost savings associated with the potential use of existing infrastructure (i.e. buildings, roads, power, and communications). The assessment concluded that the establishment and operation of the new facility would have no significant impact on the overall environment of the region at any of the tree locations.

4.5.2 RCRA Facility Assessment (1988)

As part of the RCRA permit application, WSMR was required to conduct an RFA to determine whether there was a potential or an actual release of hazardous waste or hazardous waste constituents at the facility. Distinct locations of potential contamination were identified as SWMUs. Less defined areas of potential

contamination were referred to as AOCs. The RFI was conducted by A.T. Kearney, Inc. (A.T. Kearney), and the results of the assessment was provided within an RFA Summary Report. WSMR submitted the RFA Report to USEPA Region 6 in 1988 that identified 138 SWMUs and 26 AOCs. Among these sites, 17 SWMUs and 3 AOCs were located in the HELSTF.

4.5.3 USAEHA Evaluation (1990)

The U.S. Army Environmental Hygiene Agency (USAEHA) conducted an evaluation of environmental conditions at the HELSTF in July 1990. This evaluation was conducted to facilitate the transfer of command between WSMR and the U.S. Army Strategic Defense Command. Their report identified another 28 sites with suspected releases (USAEHA, 1990). Eventually, 13 of these sites were placed in the HSWA module of the permit as SWMUs.

4.5.4 Phase I RFI (1991)

The Phase I RFI was conducted in 1991 by ITC. This Phase I RFI was conducted for specific SWMUs as follows:

- Phase I RFI for 18 SWMUs listed on Appendix I of the RCRA Permit. Of these, 4 SWMUs (27, 28, 29, and 30 [now combined as SWMU 27]) were located at the HELSTF. The results of this investigation were provided within a summary report (ITC, 1992a); and

- Phase I RFI for 46 SWMUs listed on Appendix II and III of the RCRA Permit and 17 SWMUs listed on Appendix IV of the RCRA Permit. Of these, 17 SWMUs were located at the HELSTF. The results of this investigation were provided within a summary report (ITC, 1992b).

The reports for these investigations were provided to both NMED and the USEPA for review and approval. The reports provide details regarding sampling methodologies, analytical programs, data evaluation methodologies and results, conclusions, and recommendations.

4.6 Phase II RFI (1993)

The Phase II RFI was conducted during 1993 by SEI. The Phase II RFI further defined the character and extent of contamination at 52 SWMUs across WSMR, including 12 at

the HELSTF. No additional SWMUs were identified at the HELSTF. The results of the investigation were presented in a report (SEI, 1994). The report for this investigation was provided to both NMED and the USEPA for review and approval. The report provides details regarding sampling methodologies, analytical programs, data evaluation methodologies and results, conclusions, and recommendations.

4.7 Phase III RFI (2006 – 2009)

A Phase III RFI Work Plan was prepared by WTS in 2006. The Phase III RFI Work Plan (WTS, 2006) was subsequently approved by NMED on May 24, 2007. The Phase III RFI Work Plan addressed contaminant releases within the HELSTF that included 30 SWMUs and 3 AOCs. The objective of the Phase III RFI scope was to provide a comprehensive evaluation of all previously known contaminant releases and the associated risk at the HELSTF that will lead to final corrective measures.

The field program for the investigation was implemented in 2006 and 2007 and included the collection of soil and groundwater samples, the installation of new monitoring wells, the assessment and redevelopment of existing monitoring points, and the establishment of new monitoring point elevations for all locations.

Thirty-eight new soil borings were drilled and sampled at eight SWMUs. Thirteen monitoring wells were installed as part of the field program. Groundwater samples were collected from newly installed and existing monitoring wells sites as proposed in the Phase III RFI Work Plan. All field program activities were conducted by WTS in accordance with the Methodologies described under Section 5.1 (Investigation Methods, page 70). The samples were analyzed following the analytical program described under Section 5.2 (Analytical Program, page 72).

Deviations to the Phase III RFI identified by WTS included the following:

- All drill sites (boring and monitoring wells) were marked on the ground based on maps presented in the Work Plan. However, several locations were shifted slightly to avoid utilities or to provide drill rig access. Final locations were surveyed and recorded;

- Background soil sampling locations were moved substantially (roughly 1,000 feet) to the northwest, relative to the locations marked in the Work Plan, because the pre-field mapped locations were too close to disturbed areas;

- One soil boring, SB-17 proposed for SWMU 142, was relocated to the original HMW-54 monitoring well location due to underground utilities;

- SB-12 proposed for SWMU 142 was omitted entirely due to underground utilities. Remaining borings near this location were deemed adequate to cover the site;

- Use of the split spoon sampling device during the soil boring program did not provide adequate sample volume required for the analytical program. WTS described this condition in the previous Phase III RFI Report as follows *"due to inadequate soil sample size produced with the split spoon, numerous duplicate samples were spread over two sample intervals in the same boring whereas they were originally planned to be taken from one sample interval. The sample intervals were not composited. One set of soil samples for certain required analytes were collected from one interval while the remaining soil samples for the remaining required analytes were collected from the second interval"* (WTS, 2008);

- The numerical designations for monitoring wells were changed. Because Monitoring Wells HMW-51 and HMW-52 already existed at the HELSTF Technical Support Area (TSA), numbering of wells for this program began with HMW-53;

- Thirteen monitoring wells were installed. The original work plan called for nine. Additional wells were added at the request of NMED to fill in perceived data gaps;

- At the proposed location of Monitoring Well HMW-54, an abandoned water line was encountered during the advancement of the pilot boring. The boring was abandoned and a new location for Monitoring Well HMW-54 was selected approximately 50 feet to the southeast;

- The location of Monitoring Well HMW-64 was moved from the proposed location to an alternate location within the parking area, situated approximately 100 feet to the east. WTS believed that the proposed location was too close to an existing monitoring well;

- A water balance for the ~~current lagoons (~~SWMU~~s~~ 27 (formerly SWMUs 27 through 30) ~~through 30)~~ was not completed. WTS determined that this was not necessary because ~~the current lagoons~~ that sanitary treatment system was~~were~~ being replaced by another ~~lagoon~~ system;

- The scope of the Phase III RFI Work Plan included collection of groundwater samples from 59 monitoring wells installed in the Vadose Zone (formerly referred to as Perched Zone) and 23 monitoring wells installed in the Regional Aquifer. At the time of the Phase III RFI field program, dry well conditions existed at 23 vadose zone wells and groundwater samples could not be collected at th~~e~~o~~se~~ locations;

- All purge-and-trap alcohols were analyzed using SW-846 Method 8260B. Benzyl alcohol was analyzed using SW-846 Method 8270C. Ethylene glycol was analyzed using SW-846 Method 8015B; and

- No surface samples were collected at locations where the drilling sites were paved or covered with an artificial substrate.

Results of the field program are described under Section 6 (RCRA Facility Investigation Discussion, page 97). It should be noted that additional and recent assessment of SWMU 27 (Sanitary Treatment Impoundment at HELSTF) was conducted during 2009 as part of the Phase III RFI. A summary of the recent RFI activities at this SWMU are further described under Subsection 6.5.

4.8 SWMU Groundwater Monitoring Program

Currently, groundwater is sampled semiannually at three SWMUs at the HELSTF that include:

- The HELSTF Systemic Diesel Spill (SWMU 154) – groundwater is sampled from 11 monitoring wells (DRW-1, DRW-2, DRW-3, DRW-4, DRW-5, DRW-12, DRW-13, DRW-16, HCF-1, HCF-5, and HCF-7);

- The HELSTF Storage Yard Chromium ~~Chromate~~ Spill Site (SWMU 143) – groundwater is sampled from 9 monitoring wells (HMW-11, HMW-13, HMW-36, HMW-37, HMW-38, HMW-39, HMW-40, HMW-41, and HMW-43); and

- The ~~Construction~~ HELSTF Landfills (SWMUs 38 and 39) – groundwater is sampled from 5 monitoring wells (HMW-29, HMW-32, HMW-33, HMW-34, and HMW-35).

Groundwater is also sampled on an annual basis at SWMU~~s~~ 27 ~~through 30~~. One groundwater monitoring well (HMW-56) is routinely sampled as part of this WSMR groundwater monitoring program. Groundwater samples are analyzed for volatile

organic compounds (VOCs), total petroleum hydrocarbons (TPH), metals, total alkalinity, pH, dissolved solids, total organic carbon (TOC), anions, ammonia nitrogen, total Kjeldahl nitrogen (TKN), total cyanide, and mercury. The results of the sampling are provided to NMED.

5. Phase III Methodologies

5.1 Investigation Methods

All Phase III RFI activities were conducted in accordance with the standard operating procedures (SOPs) provided within the NMED-approved Phase III RFI Work Plan. The procedures listed in the SOPs that were followed during the Phase III RFI included:

- Field Quality Assurance;
- Chain of Custody;
- Sample Handling, Packing, and Shipping;
- Sample Labeling;
- Sample Numbering;
- On-Site Sample Storage;
- Surface and Shallow Subsurface Soil Sampling;
- Subsurface Soil Sampling While Drilling;
- Composite Sample Preparation;
- Duplicate and Split Sample Preparation;
- Water Level Measurements in Monitoring Wells;
- Field Equipment Decontamination;
- Monitoring Well Installation;

- Monitoring Well Development;
- Groundwater Sampling;
- Lithologic Logging; and
- Management of Investigative-Derived Waste.

The details pertaining to these procedures are provided in the approved SOPs that are included in Appendix A.

5.1.1 Soil Sample Collection

A total of 38 soil borings were drilled and sampled at eight different SWMUs. Samples were collected every 10 feet from the surface down to total depth. Surface samples beneath asphalt were not collected. Soil borings were advanced using the hollow-stem auger. Collection of soil samples was conducted using a split spoon sampler to minimize the disturbance of the sample.

Generally, split spoon samplers were used to collect soil from the subsurface for every 5-foot length of drilling. The site engineer logged samples as they were retrieved. The lithology of each borehole was recorded on soil boring logs presented under Appendix B. If sampling for VOCs, the soil core was screened using a photoionization detector (PID) to determine the interval with the highest vapor concentration. When sampling for constituents not associated with VOCs (or if the PID did not detect VOCs), the field supervisor used best judgment, based upon observation, to select the representative sample within the soil core. Samples were collected for analytes in the order from most volatile to least volatile. Table 5-1 presents a list of soil samples collected during the Phase III RFI.

5.1.2 Monitoring Well Installation

During the Phase III RFI, 13 new monitoring wells were installed. Drilling logs and monitoring well construction diagrams are presented as Appendix B. Drilling of monitoring wells was conducted using an auger-equipped drilling rig. ~~As part of~~ For the monitoring well installations ~~program~~, a pilot boring was advanced using a 3.25-inch inside diameter (ID) auger, then overdrilled with a 6.25-inch ID auger.

Well materials consisted of new threaded, flush joint polyvinyl chloride (PVC) Schedule 40 pipe with a 4-inch ID. With the exception of Monitoring Well HMW-62, a 5-foot section of pipe material was used to construct a sand trap or sump for each well. However, ~~at the location of HMW-62,~~ heaving sands encountered at the base of the boring for HMW-62 prevented the installation of the sand trap.

The well screen for monitoring wells consisted of new, threaded, flush joint, 4-inch-diameter PVC. The slot size for the screen was 0.010 inch. A 2- to 6-foot seal consisting of bentonite chips was placed above the filter pack and hydrated with either formation water or potable water as needed. Filter pack material consisted of clean, washed, well graded, rounded to subrounded silica sand. The filter pack was placed below the base of the sand trap to at least 2 feet above the top of the screened interval. The filter pack was installed between the riser pipe and auger as the auger was retrieved from the boring.

Upon completion of the well, a PVC cap was installed to prevent material from entering the well. The well surface completions consisted of a cement pad surrounded by protective posts. A protective above-grade aluminum shroud with locking cap was also installed as part of each surface completion.

Following well installation and construction of surface completions, each well was developed following the well development procedures described within the SOP under Appendix A. Table 5-2 presents a summary of the well construction details for all monitoring wells at the HELSTF area.

5.1.3 Groundwater Sampling

Selected monitoring wells (new and existing) were sampled using low flow purging and sampling methods. Groundwater sampling procedures and the order of sample collection followed the SOPs presented under Appendix A.

5.2 Analytical Program

The analytical testing for the Phase III RFI was conducted ~~for the constituents of concern~~ using the methodologies defined in the Phase III RFI Work Plan. All sample analyses were conducted in accordance with the methodologies specified by the USEPA under Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", also known as SW-846 (USEPA, 1999a). WTS retained Trace Analysis, Inc. (Trace), located in Lubbock, Texas, to conduct the analytical testing. ~~As previously described,~~

~~sampling~~ Sample handling and transport were conducted in accordance with ~~those~~ procedures specified in the Phase III RFI SOPs (Appendix A).

5.3 Data Evaluations

~~The overall soil data~~Data evaluations included screening the data against published standards and using the data to characterize the nature and extent of the affected media associated with each SWMU. ~~an initial data screening to identify detections and to evaluate the nature and extent of affected media associated with each SWMU. The results of the data screening were used to determine the nature and extent of constituents associated with each SWMU.~~ In order to effectively evaluate the data, ~~As part of this evaluation,~~ all analytical data collected during all phases of the RFI were entered into a computer-assisted database management system that could be used to view the data and sort by:

- SWMU Location;
- Sample Identification;
- Sample Date;
- Sample Interval;
- Analytical Method;
- Analytical Constituent;
- Sample Quantification Limit;
- Analytical Result;
- Screening Criteria; and
- Descriptions of the screening criteria used to evaluate soil and groundwater results are provided below.~~TPH concentrations were evaluated in accordance with NMED's October 2006 TPH Screening Guidelines (NMED, 2006b). However, it should be noted that there are no potable water sources beneath the HELSTF and, therefore, the standards of Table 2a (TPH Screening Guidelines for Portable~~

Groundwater [GW-1]) of the guidance were not applicable for the nature and extent evaluation. The standards of Table 2b (TPH Screening Guidelines – Vapor Migration and Inhalation of Groundwater [GW-2]) are addressed as part of the Risk Assessment described under Section 5.4 (Risk Assessment Methods, page 69). The majority of the petroleum-related constituents listed on Revised Table 3 (Petroleum-Related Contaminants Screening Guidelines) that comprise TPH were included when evaluating nature and extent for detected concentrations of VOCs and SVOCs as described in Section 6 (page 86) for each SWMU.

- The evaluation of detections in vadose zone water and regional groundwater could not be addressed on a SWMU-by-SWMU basis because the anthropogenic vadose zone water is a transport system that has resulted in an extremely complex distribution of constituents that does not always correspond well to the location of the SWMU. The distribution of constituents in groundwater is confounded by the changes in distribution of vadose zone water over time, the lack of a normal gradient in the vadose zone water, and the uncertainty as to the locations where vadose zone water connects to the regional groundwater. Because of this, COPC occurrence in vadose zone water and regional groundwater was evaluated on a more holistic basis, as discussed in Section 6.25 (page 287).

- Descriptions of the screening criteria used to evaluate soil and groundwater results are provided below.

5.3.1 Soil Data Screening

As part of this soil evaluation, soilSoil results were evaluated using criteria established by the USEPA and NMED as follows:

- NMED. Technical Background Document for Development of Soil Screening Levels, Revision 4.0. Hazardous Waste Bureau and Groundwater Quality Bureau, Voluntary Remediation Program. June 2006August 2009 (with minor revisions December 2009); and USEPA. USEPA Regional Screening Levels. September 2008.

As part of screening, soil data were also subdivided into two data sets that included:

- SSoil - amples collected between 0 and 0 to 10 ft bgs and samples collected from depths greater than 10 ft bgs. This subdivision of the data was performed because only the data collected from the upper 10 feet are – This soil horizon is considered

for potential human health and ecological exposure. as part of the human health and ERA further described under Section 5.4 (Risk Assessment Methods, page 69). Additionally, metals data from this horizon were further evaluated using the results of the Background Characterization Study described under Section 4.4 (Background Study, page 55); and

- Soil - greater than 10 ft bgs – This soil horizon is not to be considered as part of the risk assessment because human or ecological exposure to media at this depth is not likely. Additionally, soil samples collected at depths greater than 10 ft bgs may be representative of saturated conditions associated with the vadose zone water.

The hierarchy for screening the soil data sets for soilSoil data collected from between 0 and to 10 ft bgs were screened according to the following hierarchy: is presented below:

- Use the Data were compared to the residential soil screening levels (SSL) established by the NMED (NMSSLs);and USEPA (EPASSLs) a
- Overall screening criteria;
- Use the NMSSLs as the primary screening criteria. If no NMSSLs have beenexist established for a constituent, the data were compared to the use EPASSLs. to screen results;
- For metals, compare concentrations data were also compared to the BSLs (described in established in Appendix F). The resultant screening criterion for metals in the upper 10 feet of soil was the greater of either the NMSSL/EPASSL or the BSL; and
- Data were also screened against the The DAF values established by NMED. for each analytical constituent was used to evaluate potential leachability to groundwater. The DAF is defined as the potential for reduction in concentration that is expressed in the ratio of original soil concentration to the receptor point of concentration. For sites where a release to groundwater occurred, the data were compared to DAF1 values. For sites where no release to groundwater occurred and the potential source area was greater than 0.5 acres, the soil data were compared to DAF10 values. For sites where no release to groundwater occurred and the potential source area was less than 0.5 acres, the soil data were

compared to DAF20 values. A summary table describing DAF determination for each SWMU is provided as Table 5-3.~~The DAF is defined as the potential for reduction in concentration that is expressed in the ratio of original soil concentration to the receptor point of concentration. As part of the soil evaluation, the lowest possible DAF (i.e., DAF = 1) was used for screening results. The results of the screening are provided as part of the nature and extent evaluations described for each SWMU under Section 6 (RCRA Facility Investigation Discussion, page 86).~~

~~The hierarchy for screening soil data sets for data~~Soil data collected from depths greater than 10 ft bgs were screened against the applicable DAF screening value, as described above and shown in Table 5-3 ~~follows~~.

- ~~For sites where a release to groundwater occurred, the data were compared to DAF1 values. For sites where no release to groundwater occurred and the potential source area was greater than 0.5 acres, the soil data were compared to DAF10 values. For sites where no release to groundwater occurred and the potential source area was less than 0.5 acres, the soil data were compared to DAF20 values. .Use of risk-based screening standards is not appropriate because human or ecological exposure to soil is not likely to occur at a depth greater than 10 feet.~~

It should be noted that historical detection limits were often above ~~the NMED DAF 1 standard.~~one or more of the screening standards. This ~~is often encountered when~~is not uncommon when comparing historical data to current investigation criteria. The historical detection limits were the lowest achievable detection limits using ~~the~~ state-of-the -art laboratory equipment and techniques available at the time. Instances where the detection limits exceed the NMED DAF ~~1~~ standard ~~and/or NMED SSLs~~ were not construed to represent an exceedance of a regulatory standard for the purposes of delineation in soil because the analysis of COPCs ~~detected~~ in associated vadose zone and regional groundwater adequately addresses the consequences of any real exceedances of leachability standards. ~~, and the resulting risk considerations.~~ Instances where the detection limits exceed the NMED SSLs were considered in the risk assessments, as described in 5.4.

5.3.2 Vadose Zone Water and Regional Aquifer Data Screening

Regulatory standards/screening values were used for ~~delineation~~ characterization of both vadose zone water and groundwater in the Regional Aquifer. In vadose zone

water, data were screened against regulatory standards/screening values in order to characterize the nature and extent of contamination and to ~~were used as a guide to confirm delineation and~~ identify constituents of potential concern (COPCs) that may ~~potentially~~ be important with respect to impacts to the Regional Aquifer. However, it is important to note that the ~~because the~~ vadose zone water does not represent a viable water resource. The regulatory criteria used to evaluate groundwater data included the following: ~~, these standards/screening values are more relevant to groundwater in the Regional Aquifer. The regulatory criteria used to evaluate these data included the following:~~

- Title 20 (Environmental Protection) New Mexico Administrative Code (NMAC) Chapter 6 (Water Quality) Part 2 (Ground and Surface Water Protection) Subsection 3103 (Standards for Groundwater of 10,000 mg/L TDS Concentration or Less) (20 NMAC 6.2.3103). These standards are also referred to as the NMED Water Quality Control Commission (WQCC) standards;

- NMED. Hazardous Waste Bureau and Groundwater Quality Bureau, Voluntary Remediation Program, Technical Background Document for Development of Soil Screening Levels, Revision 4.0, June 2006. This publication also provides screening for tapwater levels; and

- USEPA Primary and Secondary Drinking Water Standards, June 16, 2003.

The hierarchy for screening both vadose zone water and Regional Aquifer data sets is presented below:

- Groundwater data were compared to the ~~The~~ lowest value of the USEPA Maximum Contaminant Level (MCL) (USEPA, 2003a) or NMED WQCC (1995) standards; ~~was used;~~

- If neither a NMED WQCC nor a USEPA MCL exists for an analyte, then the groundwater data were compared to the New Mexico Tapwater value; ~~e was applied; and~~

- If neither a NMED ~~G~~WQCC~~S~~, a USEPA MCL, nor a New Mexico Tapwater screening value exists for a specific analyte, then the groundwater data were compared to the USEPA Tapwater screening value. ~~was applied.~~ The USEPA Tapwater screening values for carcinogenic COPCs were adjusted upward by a factor of 10 to be comparable with the New Mexico Tapwater screening values,

which are based on a target risk level of 10^{-5}. These adjustments were made based on guidance from NMED regulatory oversight (Andress, pers. comm. 2009);

- ~~TPH concentrations were evaluated in accordance with NMED's October 2006 TPH Screening Guidelines (NMED, 2006b). However, it should be noted that t~~There are no potable water sources beneath the HELSTF and, therefore, the TPH standards in the NMED's October 2006 TPH Screening Guidelines (NMED, 2006b) are not applicable.~~of Table 2a (TPH Screening Guidelines for Portable Groundwater [GW-1]) of the guidance were not applicable for evaluating the nature and extent of the affected groundwater.~~ However, ~~T~~t he standards of Table 2b (TPH Screening Guidelines – Vapor Migration and Inhalation of Groundwater [GW-2]) are addressed as part of the Risk Assessment described under Section 5.4 (Risk Assessment Methods, page 79). It should be noted that ~~T~~the majority of the petroleum-related constituents that comprise TPH and listed on Revised Table 3 (Petroleum-Related Contaminants Screening Guidelines) of the guidance document ~~that comprise TPH~~ were included in the evaluation of VOCs and SVOCs; and

- The evaluation of detections in vadose zone water and regional groundwater could not be addressed on a SWMU-by-SWMU basis because the anthropogenic vadose zone water is a transport system that has resulted in an extremely complex distribution of constituents that does not always correspond well to the location of the SWMU. The distribution of constituents in groundwater is confounded by the changes in distribution of vadose zone water over time, the lack of a normal gradient in the vadose zone water, and the uncertainty as to the locations where vadose zone water connects to the regional groundwater. Because of this, COPC occurrence in vadose zone water and regional groundwater was evaluated on a more holistic basis, as discussed in Section 6.25 (page 351).

5.3.3 Data Quality Screening

The analytical program included a comprehensive analysis of VOCs and SVOCs. However, several of the organic compounds included in the VOC and SVOC analyses are common laboratory contaminants and their detections may not be representative of soil or groundwater quality.

Acetone and methylene chloride are very common laboratory contaminants and are often reported in soil and groundwater data as a result of cross-contamination that occurs in the laboratory or during field decontamination. Acetone is used as a solvent

in the laboratory for rinsing glassware, and may cause airborne or residual laboratory contamination. It can also be found in isopropanol, which can be used as a solvent rinse for field equipment. Methylene chloride is used as an extraction solvent for SVOCs in the laboratory. Other common laboratory contaminants include carbon disulfide, phthalates, and dichloromethane.

According to the USEPA's Functional Guidelines for Organics, these constituents can be eliminated from consideration when their concentration is less than ten times the concentration found in associated laboratory blanks. It should be noted that a number of soil samples collected during the Phase I RFI in 1992 reported acetone and/or methylene chloride.

Due to the age of the data, laboratory blanks associated with these data were not available for review. Equipment and field blanks were not included in the data set that is available. Quality assurance data were not as stringently enforced during the timeframe of these samples. Therefore, ~~these~~ detections of common laboratory contaminants~~detections~~ were eliminated from further consideration in cases where there was no evidence that these constituents were associated with historical operations at the SWMU and the detection was less than 10 times the reported detection limit for the individual sample.

Historic environmental sampling and analysis data were used in developing this RFI to denote potential environmental impacts. These data were generated from 1991 to 2009 and were presented to ARCADIS in data tables. The data tables contained the results of sample analytical results and laboratory contaminants only, no results for other quality control samples (e.g. blanks, duplicates, etc.), or raw data were supplied or reviewed by ARCADIS.

The use of historic data in developing RFIs and similar documents is a common practice. In most instances, historic data have been previously reported and have likely undergone review and/or validation. Therefore, these data were not validated by ARCADIS in developing this Revised RFI Report.

5.4 Risk Assessment Methods

5.4.1 Risk Assessment Data Sets

Samples collected during the Phase I, Phase II, and Phase III RFI site investigations were considered for inclusion in the risk assessment. The environmental data collected

throughout the various phases of investigation were grouped by SWMU and medium of interest (e.g., soil and groundwater) and then evaluated to produce risk assessment data sets. Soil data were also subdivided into a data set (0 to 2 feet) for evaluating human exposure (current/future site worker; hypothetical future resident) and ecological receptors, a combined surface and subsurface data set (0 to 10 feet) for evaluating human exposure (future construction worker) and ecological receptors that could be exposed to subsurface soil (e.g., burrowing wildlife), and a total soil data set (vadose zone) for evaluating human exposure (potential for vapor intrusion). Groundwater data were also subdivided into a vadose zone water data set on a SWMU-by-SWMU basis for evaluating human exposure (potential for vapor intrusion), and the deep Regional Aquifer data were evaluated as a single data set for human exposure.

The following components were considered in the preparation of the risk assessment data sets: data quality, sample and result type, data qualifications, vertical and spatial distribution of the data, and constituent classification (e.g., polycyclic aromatic hydrocarbons [PAHs]). Each of these considerations is discussed in detail within the comprehensive Risk Assessment presented in Appendix E. Appendix E includes a discussion of the methods and procedures utilized during the risk assessment activities, as well as the findings of the human health and ERAs for all of the individual SWMUs discussed in this report.

After the risk assessment data sets were prepared, the data included in each data set were summarized, statistically analyzed, and then tabularized by highlighting the number of detects, number of samples, frequency of detection (FOD), minimum and maximum detected concentrations, and minimum and maximum detection limits.

5.4.2 Human Health Risk Assessment (HHRA) and Procedures

Site-specific HHRAs were conducted at each of the SWMUs evaluated in this RFI report. The purpose of the HHRAs was to evaluate the potential current and future potential risks and hazards to human health associated with constituents detected in surface and subsurface soil and groundwater samples collected at the HELSTF sites. Methods and parameters used in the HHRA were consistent with NMED and USEPA guidance for risk assessments (NMED, ~~2006a~~2009a; USEPA, 2000a; 1997a; 1992a; 1991a; 1991b; 1989). The HHRA methods are discussed in detail in Appendix E and are briefly summarized in the text below.

5.4.2.1 *Constituent Characterization*

This section discusses the methods used to select COPCs for the HHRA.

COPCs were identified for each of the SWMUs by comparing maximum concentrations to NMED (~~2006~~2009b) SSLs for residential soil. In the event that NMED guidance did not have a screening level for a given constituent, the USEPA Regional Screening Levels (SLs) (USEPA, ~~2008a~~2009a) for residential soil were used. NMED SSLs are based on a carcinogenic target risk level of 1×10^{-5} and non-carcinogenic target hazard quotient of 1. The USEPA (~~2008a~~2009a) screening levels are based on a carcinogenic target risk level of 1×10^{-6} and a non-carcinogenic target hazard quotient (HQ) of 1. To be consistent with NMED guidance and target risk level of 1×10^{-5}, the carcinogenic USEPA (~~2008a~~2009a) screening levels were adjusted upward by a factor of 10.

Constituent concentrations observed in regional groundwater were compared to screening levels developed assuming ingestion of water under a future residential exposure scenario. Constituents present at concentrations greater than their screening level were identified as COPCs. The hierarchy for screening the regional groundwater data set is presented below:

1. The lowest value of the USEPA MCL (USEPA, 2003a) or NMED WQCC standards (NMED WQCC, 1995) was used.

2. If an analyte does not have a USEPA MCL or NMED standard, the NMED Tapwater screening level (NMED, ~~2006a~~2009b) was used.

3. If an analyte does not have an NMED Tapwater screening level, the USEPA regional tapwater screening level (for carcinogens, the USEPA Tapwater screening level was adjusted upward by a factor of 10) (USEPA, ~~2008a~~2009a) was used.

For shallow vadose zone water at the site, which is not currently used for potable water, nor will it be used in the future, concentrations detected in the shallow vadose zone water were compared to vapor intrusion screening levels (USEPA, 2002c).

The focus of the site-specific risk assessments is on those constituents that are related to activities at specific source areas at the HELSTF sites. Inorganic constituents may be present at a site because of naturally occurring sources. As a result, the site-specific inorganic data were compared to the site-specific background data as

presented in the Background Characterization Report (Appendix F of this report). Constituents present at or below background levels were excluded from further evaluation in the risk assessment.

In summary, the selection of COPCs for the HHRA is based primarily on the magnitude of the measured concentrations in the relevant environmental media, in relation to the appropriate screening level. Detected constituents for which a screening level is not available ~~were~~ are also ~~included as COPCs~~considered in the screening process.

For screening data at sites with multiple constituents, the following procedure was followed in accordance with NMED guidance (NMED, 2009a): separate the constituents by carcinogens and non-carcinogens, take the site-specific constituent concentration (represented by the maximum reported concentration as an initial step), and divide by the screening level concentration for each constituent. For multiple constituents, simply add the ratio for each constituent and multiply by $1x10^{-5}$ for carcinogens or multiply by 1 for non-carcinogens. If the total screening risk is greater than the target risk level of 1×10^{-5} for carcinogens and/or greater than the target hazard index of 1 for non-carcinogens, then the concentrations at the site warrant further, site-specific evaluation in a risk assessment. Screening risk and hazard indices less than the target levels indicate that the concentrations at the site are unlikely to result in adverse health impacts (NMED, 2009a).

~~For screening data at sites with multiple COPCs, the following procedure was followed (as per NMED, 2006a SSL guidance) to evaluate the potential additivity of adverse effects: take the site-specific concentration (represented by the maximum reported concentration in the primary evaluation, or the 95 percent Upper Confidence Limit [UCL] concentration in the secondary evaluation) and divide by the screening level concentration for each analyte. For multiple constituents, simply add the ratio for each constituent. If the total ratio is greater than 1, then the concentrations at the site warrant further, site-specific evaluation. A ratio less than 1 indicates that the concentrations at the site are unlikely to result in adverse health impacts (NMED, 2006a).~~

A full discussion of the derivation of the human soil screening levels used is presented in Appendix E and the screening levels are presented in Table E.2-2 of Appendix E.

5.4.2.2 *Exposure Assessment*

The exposure assessment for the HELSTF is described in detail in Appendix E. The basic components of the exposure assessment steps are summarized below.

5.4.2.2.1 Receptors and Exposure Pathways

Exposure pathways ~~are~~ identified in Section ~~3.5.3.1~~2.2.3.1 of ~~the HHRAs within~~ Appendix E are based on the site characterization information and the fate and transport properties of the constituents detected on~~-~~site to identify likely points where human receptors may come in contact with affected media under current or potential future conditions at the HELSTF sites. The following receptors and potentially complete and significant exposure pathways were identified for quantitative analysis at the sites:

Current/Future Site Worker Receptor

- Dermal contact with surface soil;
- Incidental ingestion of surface soil;
- Inhalation of particulates in outdoor air;
- Inhalation of volatile COPCs in ambient air (if VOCs are identified as COPCs); and
- Inhalation of volatile COPCs migrating to indoor air (if VOCs are identified as COPCs).

Future Construction Worker Receptor

- Dermal contact with surface and subsurface soil;
- Incidental ingestion of surface or subsurface soil;
- Inhalation of particulates in outdoor air during soil intrusive activities; and
- Inhalation of volatile COPCs in surface and subsurface soil in ambient air (if VOCs are identified as COPCs).

Hypothetical Future Adult and Child Resident

- Dermal contact with surface and subsurface soil;
- Incidental ingestion of surface and subsurface soil;
- Inhalation of particulates (from soil) in ambient air during outdoor activities;
- Inhalation of volatile COPCs in ambient air (if VOCs are identified as COPCs);
- Inhalation of volatile COPCs in indoor air (if VOCs are identified as COPCs) either from groundwater use in the home or from vapor migration into the home; and
- Ingestion of and dermal contact with groundwater used domestically.

5.4.2.2.2 Exposure Point Concentrations

Exposure point concentrations (EPCs) are representative constituent concentrations that a receptor may contact at an exposure point over the exposure period (USEPA, 1989). Ideally, the EPC should be the true average concentration; however, because of the uncertainty associated with estimating the true average concentration based on a limited data set, the estimated UCL on the mean (i.e., a UCL of 95 percent or higher) should be used as the EPC. The maximum concentration is used as the EPC where the UCL cannot be calculated.

EPCs were calculated for COPCs by medium at each SWMU consistent with guidance as discussed in detail in the SWMU-specific reports within Appendix E. The surface soil, combined surface and subsurface soil, total soil, and groundwater EPCs are presented in the SWMU-specific data summary tables discussed in Appendix E of this RFI report.

5.4.2.2.3 Exposure Parameters

Exposure parameters are values used to quantify the assumed exposure to COPCs for each receptor. For this HHRA, exposure parameters that represent the reasonable maximum exposure scenario were selected.

The receptor-specific exposure parameters are summarized in Tables E.2-11 through E.2-19 within Appendix E and are discussed in detail within Appendix E.

5.4.2.3 *Toxicity Assessment*

Toxicity values for potential non-carcinogenic (reference doses [RfDs]) and carcinogenic effects (cancer slope factors [CSFs]) were obtained from the following sources in order of priority following USEPA (2003b) guidance:

- Tier 1: USEPA's Integrated Risk Information System (IRIS) (USEPA, 2009b);
- Tier 2: National Center for Environmental Assessment (NCEA) Provisional Peer Reviewed Toxicity Values (PPRTV); and
- Tier 3: Additional USEPA and non-USEPA sources including the Agency for Toxic Substances and Disease Registry (ATSDR), the USEPA (2004a, b), and USEPA's Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997b).

Toxicity values are presented in Tables E.2-6 through E.2-9 within Appendix E.

5.4.2.4 *Risk Characterization*

The equations used in the risk characterization calculations are presented in Tables E.2-11 through E.2-19 within Appendix E.

Potential risks to human health were evaluated quantitatively by combining calculated exposure levels (i.e., dose) and toxicity data. A distinction is made between non-carcinogenic and carcinogenic endpoints as discussed in the sections below.

5.4.2.4.1 Non-carcinogenic Effects – Hazard Quotients and Hazard Indices

Exposure doses were averaged over the expected exposure period to evaluate non-carcinogenic effects. The hazard quotient (HQ) is the ratio of the estimated exposure dose and the RfD. An HQ greater than 1 indicates that the estimated exposure level for that constituent is greater than the RfD. This ratio does not provide the probability of an adverse effect. Although an HQ of 1 indicates that health effects should not occur, an HQ that is greater than 1 does not imply that health effects will occur, but that health effects are possible.

The sum of the HQs is the hazard index (HI). A limitation with the HI approach is the assumption of dose additivity is applied to compounds that may induce different effects

by different mechanisms of action. Consequently, the summing of HIs for a number of compounds that are not expected to induce the same type of effects or that do not act by the same mechanism may overestimate the potential for toxic effects (USEPA, 1989). Consistent with USEPA risk assessment guidelines for constituent mixtures, in the event that the total HI for an exposure scenario is greater than 1, it is incumbent on a risk assessor to segregate HQs by target organ/critical effect (NMED, 2009a; USEPA, 1989). Therefore, if the calculated HI is greater than 1 as a consequence of summing several HQs for constituents not expected to induce the same type of effects or that do not act by the same mechanism, the HIs were be segregated by effect and mechanism of action to derive separate HIs for each target-organ/critical-effect group (NMED, 2009a; USEPA, 1989). Where target organ HIs exceeded one, the constituents of concern contributing to those HIs are identified.

5.4.2.4.2 Carcinogenic Effects – Excess Lifetime Cancer Risk

The excess lifetime cancer risk (ELCR) is an estimate of the potential increased risk of cancer that results from lifetime exposure, at specified average daily dosages, to COPCs at a site. Estimated doses or intakes for each COPC are averaged over the average lifetime of 70 years. It is assumed that a large dose received over a short period is equivalent to a smaller dose received over a longer period, as long as the total doses are equal. The ELCR is calculated as the product of the exposure dose and the CSF. The use of upper percentile EPC and reasonable maximum exposure parameters result in a risk estimate that is considered to be an upper-bound estimate; in other words, the true risk is less than that predicted by the model.

The USEPA considers ELCRs within the target risk range of 10^{-6} to 10^{-4} to be generally acceptable.

5.4.2.4.3 Evaluation of Lead Exposures

Exposure to lead is evaluated differently than the other constituents. Cancer risk and non-cancer HQs are not estimated from exposure to lead because health effects from exposure to lead are better characterized by estimating the amount of lead that may reach the bloodstream following exposure. Consistent with current USEPA guidance (USEPA, 2003b), NMED SSLs for lead were calculated using the USEPA's Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK; USEPA, 2005). This model was used to back calculate soil concentrations for children and adults (based on a pregnant mother's capacity to contribute to fetal blood lead levels), or when evaluating occupational scenarios at sites where access by children is reliably

restricted, that would not result in an estimated blood-lead concentration of 10 micrograms per deciliter (µg/dL) or greater (residential adult of 400 milligrams per kilogram [mg/kg] and industrial and construction worker of 800 mg/kg).

5.4.2.5 *Uncertainties in the Human Health Risk Assessment*

The risk estimates presented ~~herein~~ in Appendix E are a conservative estimate of potential risks associated with exposure to constituents detected in soil and groundwater at the HELSTF sites. Uncertainty is inherent in the risk assessment process, and a discussion of these uncertainties is presented in each SWMU-specific HHRA within Appendix E. Each of the three basic building blocks for risk assessment (monitoring data, exposure scenarios, and toxicity values) contributes uncertainties. Each of the uncertainties is accounted for by using conservative assumptions wherever site-specific data are unavailable so that the overall risk estimates are conservative and therefore any decision based upon the risk estimates would be health-protective.

5.4.3 Ecological Risk Assessment (ERA) Methods and Procedures

Site-specific ERAs were conducted at each of the SWMUs evaluated in this RFI. The purpose of the ERAs is to evaluate the potential current risks and potential hazards to ecological receptors associated with constituents detected in surface soil conditions at the HELSTF sites.

The ERAs were conducted in a manner consistent with NMED and USEPA guidance for ERA (NMED, 2008; USEPA, 1997c ; 2000a; 2001a). The ERAs are intended to provide a conservative understanding of environmental conditions as they relate to the protection of wildlife populations and communities for risk management decision-making at the HELSTF.

In accordance with USEPA guidance, the ERAs conducted for the SWMU(s) at the HELSTF are comprised of a SLERA and a BERA (USEPA, 1997c; 2000a; NMED, 2008). The SLERA evaluates the potential risk to terrestrial ecological receptors exposed to constituents in surface and subsurface soil. The SLERA provides a conservative estimate of potential ecological risks and compensates for uncertainty by incorporating numerous conservative assumptions. The purpose of the SLERA is to determine whether there is a high probability that there are no ecologically significant risks that would merit additional evaluation as provided by a BERA (USEPA, 1997c; 2000a). If the results of the SLERA warrant a BERA, the information developed in the

SLERA is used to help focus the BERA. The BERA is more complex than the SLERA and uses more realistic and site-specific information about potential exposures and effects in order to evaluate potential ecological risks. Appendix E provides detailed information on the methods used in the ERA. The methods are also briefly described in the following sections. Appendix E also contains the complete ERAs for each of the SWMUs discussed in this RFI.

5.4.3.1 *Screening Level Ecological Risk Assessment*

A SLERA conservatively estimates potential risks that may affect ecological receptors, including terrestrial and aquatic organisms. The SLERA typically compensates for uncertainty in a precautionary manner, by incorporating numerous conservative assumptions. The outcome of the SLERA is the conclusion that either there is a high probability that ecologically significant risks are not posed to receptors, or further investigation in the form of a BERA is warranted. The SLERA is comprised of the following steps:

- Step 1: Screening-Level Problem Formation;
- Step 1: Screening Level Ecological Effects Evaluation;
- Step 2: Screening Level Exposure Estimate and Risk Calculation; and
- Scientific Management Decision Point (SMDP).

For each of the SWMUs, a SLERA was conducted following the typical steps in a SLERA, also incorporating some steps specific to NMED (2008). Methods used during those steps of the SLERA are described in detail in Appendix E and are summarized below.

5.4.3.1.1 Step 1: Screening-Level Problem Formulation and Screening Level Ecological Effects Evaluation

Step 1 of a SLERA consists of both a screening level problem formulation and a screening level ecological effects evaluation. The screening-level problem formulation presents background information on site characterization, receptors, ecosystem characteristics, as well as information on the sources and effects of the stressors (USEPA, 1998). This information is used to develop a CSM that illustrates the potential relationships between stressors, pathways, and receptors such as:

- Environmental Setting;
- Identification of Constituents Detected;
- Description of Constituent Fate and Transport Pathways;
- Description of Constituent Mechanisms of Ecotoxicity;
- Description of Potentially Exposed Receptors;
- Identification of Potentially Complete Exposure Pathways; and
- Selection of Generic Assessment and Measurement Endpoints.

For the HELSTF sites, hypothetical assessment endpoints include the following:

- Sustainability of small mammal populations;
- Sustainability of avian populations;
- Sustainability of terrestrial plant communities; and
- Sustainability of soil invertebrate communities.

Because direct measurement of assessment endpoints is often difficult or impossible, surrogate endpoints called measurement endpoints are used to provide the information necessary to evaluate whether the values associated with the assessment endpoint are being protected. A measurement endpoint is defined as a measurable ecological characteristic and/or response to a stressor (USEPA, 1998). HQs typically serve as the measurement endpoints for SLERAs.

5.4.3.1.2 Screening-Level Ecological Effects Evaluation

The screening-level ecological effects evaluation involves the identification of ecological screening levels (ESLs) for each detected constituent found in each environmental medium at the HELSTF sites. ESLs are generally based on effects such as mortality and reproductive impairment, and are assumed to be widely applicable to sites around the United States for screening purposes (USEPA, 1997c). For most constituents and receptors, the data available to generate ESLs are limited

and related to effects on individual organisms, rather than populations or communities. Given these limitations, conservative assumptions are typically used to ensure that the ESLs are protective. ESLs available in the literature are screening values and do not constitute remediation goals, as they are sometimes based on highly conservative exposure assumptions and/or wildlife receptors that may not be applicable to a particular site. As such, their robustness and biological association with the assessment endpoint may be limited. However, conservative benchmarks provide a starting point for the SLERA in that they may provide an indication of the worst-case measure of the potential for adverse effects. Typically, in a SLERA, ESLs are gathered from one or two sources leaving constituents without ESLs to be evaluated in the BERA. In this SLERA, ESLs were gathered from several sources during the modified SLERA to preserve effort in the BERA.

The following hierarchy was used to identify soil ESLs for the SLERA:

- USEPA Ecological Soil Screening Levels (EcoSSLs) (USEPA, 2008a~~b~~) (http://www.epa.gov/ecotox/ecossl/);
- USEPA Region 4 Ecological Soil Screening Values (USEPA, 2001b); and
- USEPA Region 5 EcoSSLs (USEPA, 2003c).

Additional or alternative sources of screening values identified by NMED were incorporated into the SLERA as appropriate.

Further, in this step, constituents that have a tendency to bioaccumulate were also identified if they are included in the USEPA list of bioaccumulative compounds (USEPA, 2000b).

Soil ESLs for constituents detected on site are presented in Table E.2-22 within Appendix E.

5.4.3.1.3 Step 2: Screening-Level Exposure Estimate and Risk Calculation

The screening-level exposure assessment is comprised of the identification of exposure estimates, risk calculations, and the evaluation of uncertainties (USEPA, 1997c; 1999b; 2001a). These components form the lines of evidence necessary to support the SMDP at the conclusion of the SLERA.

Exposure estimates used for the modified SLERA were the maximum detected concentrations for each constituent (USEPA, 1997c; 2001a). This conservative approach (i.e., using only the maximum detected concentrations) is appropriate for a screening-level effort.

Risks to ecological receptors are calculated by dividing the exposure estimates (i.e., the maximum detected concentrations) by the conservative ESLs. The resulting ratio, the "maximum HQ", is a highly conservative surrogate for the assessment endpoints. HQs equal to or less than a value of 1 (to one significant figure) indicate that adverse or significant ecological effects are unlikely (USEPA, 1997c). Maximum HQs greater than 1 indicate that further evaluation is warranted to evaluate the potential for adverse ecological effects. Therefore, the constituents with HQs greater than 1 are identified as constituents of potential ecological concern (COPECs) and carried forward into Step 3a of the BERA, except where the constituents are inorganics with maximum concentrations that are not greater than background levels. The comparison with background is typically done in the first step of a BERA; however, in accordance with NMED (2008), it was done here in the modified SLERA. Constituents were also identified as COPECs if no ESL was available.

5.4.3.1.4 Scientific Management Decision Point

SMDPs represent critical steps in the ERA process where risk management decision-making occurs. As was previously stated, the BERA is conducted for constituents with HQs that exceed 1 and constituents that lack ESLs. Reporting occurs after either Step 2 or Step 3a, depending on the results obtained in Step 2, so that additional evaluation of risks can be performed if needed and reporting can be streamlined into a single report (USEPA, 2000a). Generally, the following types of decisions are considered at this SMDP:

- Whether the available information is adequate to conclude that ecological risks are negligible and, therefore, there is no need for remediation on the basis of ecological risk;
- Whether the available information is not adequate to make a decision at this point, and the ERA process should continue; and
- Whether the available information indicates a potential for adverse ecological effects, and a more thorough assessment or remediation is warranted.

The results of the screening-level risk calculations determine if the ERA should continue into the BERA as described in the following sections.

5.4.3.2 *Baseline Ecological Risk Assessment*

The BERA is designed to more realistically identify the nature and extent of ecological risks to support informed risk management decision-making (USEPA, 1997c; 2000a). This approach contrasts with the SLERA, which is designed to conservatively rule out further evaluation of constituents and media that clearly do not pose a significant ecological risk.

This section presents Step 3a of the BERA for the HELSTF sites, which is a refinement of the Step 2 exposure estimates and risk characterization, and focuses only on COPECs that were not eliminated in the SLERA. The refinement of the assessment presented in Step 1 and Step 2 is necessary to help focus and streamline further risk assessment activities on the constituents that pose the greatest potential risk to ecological receptors (USEPA, 1997c; 1999b; 2000a; 2001a). It is intended as an "incremental iteration of exposure, effects, and risk characterization" (USEPA, 2001a) and is consistent with NMED guidance (NMED, 2008) which indicates that the refinement process provides for a more detailed, site-specific risk assessment. The outcome of this refined screening process is a list of COPECs to be retained for further evaluation in the BERA process.

The Step 3a discussion for the HELSTF sites is comprised of the following:

- Refinement of COPECs;
- Refinement of Risk Calculations for Direct Contact COPECs;
- Assessment for Bioaccumulative COPECs; and
- Uncertainties.

Step 3a is followed by an SMDP that involves the reporting of results of Steps 1 through 3a.

5.4.3.2.1 Refinement of Constituents of Potential Ecological Concern and Direct Contact Risk Estimates

The process for refining the COPECs involved the comparison of more realistic/refined EPCs such as the UCL, with the ESLs used in the SLERA. In the event the calculated UCL was greater than the maximum detected concentration, then the maximum concentration was used as the EPC. However, in some instances refined EPCs were not calculable due to limited data; therefore, refined HQs were not able to be calculated.

Risk calculations are typically refined by 1) using refined EPCs (as discussed above) and 2) using refined ESLs. There are numerous reasons to include alternative ESLs, most notably to fill any gaps in the set of ESLs used in the SLERA and to identify concentrations at which adverse effects are likely (e.g., probable effects values), rather than just possible.

The list of COPECs was refined in this BERA by refining the HQs. The refined HQs were calculated for the COPECs identified in the SLERA, using refined EPCs and, if available, alternative ESLs (e.g., Oak Ridge National Laboratory ecological benchmarks), which is consistent with the approach for "incremental iteration of exposure, effects, and risk characterization" (USEPA, 1997c; 2001a). Constituents identified as COPECs in the BERA that are bioaccumulative were evaluated using food chain models.

5.4.3.2.2 Assessment and Measurement Endpoints for Bioaccumulative COPECs

Following the identification of bioaccumulative COPECs, the assessment and measurement endpoints at the HELSTF were refined. Additional assessment and measurement endpoint are summarized below:

Additional Assessment and Measurement Endpoints		
Assessment Endpoint	**Measurement Endpoint**	**Effects Measured**
Survival and reproductive success of mammals exposed to bioaccumulative compounds in the terrestrial food chain	Adverse changes in survival and reproduction as indicated by food chain modeling for mammalian indicator species	NOAELs and LOAELs related to adverse chronic effects, such as reduced survival and reduced litter size
Survival and reproductive success of birds exposed to bioaccumulative compounds in the terrestrial food chain	Adverse changes in survival and reproduction as indicated by food chain modeling for avian indicator species	NOAELs and LOAELs related to adverse chronic effects, such as eggshell thinning or reduced fledgling survival

NOAEL No observed adverse effect level.

LOAEL Lowest observed adverse effect level.

A discussion of the mammalian and avian receptors selected as measurements endpoints at the HELSTF is presented in Appendix E and the receptors selected as indicator species are listed below:

Indicator species chosen are as follows:

- Herbivorous bird: mourning dove (*Zenaida macroura*);
- Insectivorous bird: cactus wren (*Campylorhynchus brunneicapillus*);
- Carnivorous bird: red-tailed hawk (*Buteo jamaicensis*);
- Herbivorous mammal: Merriam's kangaroo rat (*Dipodomys merriami*);
- Insectivorous mammal: desert shrew (*Notiosorex crawfordi*); and
- Carnivorous mammal: desert kit fox (*Vulpes macrotis*).

Wildlife receptor exposure parameters were gathered from USEPA (1993a; b) and from literature sources as applicable. Wildlife receptor exposure parameters are summarized in Appendix E.

5.4.3.2.3 Food Chain Modeling

Bioaccumulative COPECs were identified and assessed via food chain modeling. Food chain models predict potential detrimental effects to wildlife survival and reproduction. Intake measurements are a conservative estimate of exposure through the food chain. Food sources for terrestrial receptors in the model include soil, vegetation, invertebrates, and small mammals. Measured COPEC concentrations in the soil were used in the model. To estimate concentrations in plants, invertebrates, and small mammals, bioconcentration factors (BCFs) and bioaccumulation factors (BAFs) were used. BCFs describe the transfer (uptake) of a constituent from environmental media into tissues of vegetation and organisms in the food chain, while BAFs describe the transfer (uptake) of a constituent from dietary tissue into tissues of organisms in the food chain. The following medium-biota BCFs and BAFs were developed:

- Soil-to-Vegetation Uptake ($BCFsl_v$);
- Soil-to-Invertebrate Uptake ($BCFsl_i$); and
- Soil-to-Mammal/Bird Uptake ($BAFsl_{mam}$).

The soil BCFs and BAFs for the COPECs are identified in Table E.2-26 within Appendix E. The tables include the sources where each value was obtained.

5.4.3.2.4 Intake Assessment

Daily intake represents an estimate of a COPEC dose that a receptor might receive on a daily basis, and is calculated by summing intakes for assumed exposure pathways (i.e., dietary composition types) for each receptor. Intake is calculated by combining the concentration of a COPEC in an exposure media (e.g., soil) with applicable receptor exposure assumptions. Two types of exposure concentrations were used in the BERA. For the maximum scenario, EPCs based on the lesser of the maximum and UCL were used as exposure concentrations, and for the refined scenario, arithmetic means were used as the exposure concentrations.

To estimate the concentration of a bioaccumulative COPEC in a secondary food source (vegetation, invertebrates, small mammals), BAFs are used. To estimate intake in the wildlife receptor, the concentrations in the food sources were combined with wildlife receptor exposure parameters.

5.4.3.2.5 Effects Assessment

Food chain modeling requires the use of toxicity reference values (TRVs) to describe the potential toxicity of the COPECs to ecological receptors. The TRV is the assumed safe dose (in milligrams per kilogram body weight per day [mg/kg-BW-day]) to the receptor species. Calculation of TRVs generally relies on the use of laboratory toxicity benchmarks for laboratory species, because data on wildlife species usually are not available. Ecotoxicity benchmarks are typically reported as no observed adverse effect levels (NOAELs) and lowest observed adverse effect levels (LOAELs) for the laboratory species upon which testing was conducted.

For mammalian receptors, NOAELs and LOAELs are adjusted to account for the differences in body weights between the species tested and the receptor species (Sample et al., 1996). The extrapolation is based on the premise that metabolic

function and toxicity are related to body size (i.e., constituents are less toxic to smaller animals because they metabolize and excrete constituents faster). Therefore, mammalian toxicity values were derived from toxicity values from laboratory studies using the Sample et al. (1996) equation. Toxicity values for birds are not adjusted to reflect the different weights of test species and wildlife receptor species (Sample et al., 1996).

Avian and mammalian TRVs used in this BERA are presented in Tables E.2-27 and E.2-28, respectively, within Appendix E.

5.4.3.2.6 Risk Characterization

Potential risk was estimated using HQs, which ~~were~~ are the ratio of the concentration in a given media to the screening level in the media. For the assessment endpoint on higher trophic levels, the HQ was the ratio of the daily intake to the TRV. Equations used for risk characterization including intake equations and equations used to estimate mammalian and avian TRVs are presented in Table E.2-29 within Appendix E.

Maximum scenario risk estimates were calculated by combining EPCs, based on the UCL where calculable and maximum concentrations if not, and conservative (maximum) exposure assumptions in the food chain models. Refined scenario risk estimates were calculated by combining arithmetic mean exposure concentrations and refined exposure assumptions in the food chain models.

5.4.3.2.7 Refined Uncertainties

A BERA is designed to evaluate potential risks for wildlife by incorporating iterative changes that reduce uncertainty (when possible) and provide more realistic exposure assumptions. Uncertainties associated with the BERA are summarized in Table E.2-23 within Appendix E.

5.4.3.2.8 Scientific Management Decision Point

As discussed previously, the SMDP represents a critical step in the ERA process where risk management decision-making occurs (Figures 2-2 and 2-3 within Appendix E). An SMDP occurs after Step 2 and Step 3a (if necessary based on the results of Step 2), so that additional evaluation of risks can be conducted if needed and

reporting can be streamlined into a single report (USEPA, 2000a). Generally, the following types of decisions are considered at this SMDP:

- Whether the available information is adequate to conclude that ecological risks are negligible and, therefore, there is no need for remediation to mitigate ecological risks;
- Whether the available information is not adequate to make a decision at this point, and the ERA process should continue; and
- Whether the available information indicates a potential for adverse ecological effects, and a more thorough assessment or remediation is warranted.

If the SMDP indicates that either information is not adequate to make a decision or information indicates a potential for adverse ecological effects, then the ERA process continues.

6. RCRA Facility Investigation Discussion

6.1 COPC Selection Process for Site Characterization

For the purposes of this Revised Phase III RFI report, the data were screened according to the following criteria to identify COPCs that would be delineated and used to characterize the nature and extent of affected media.

- The analytical data for each constituent were compared to their applicable screening value as described under Section 5.3 (Data Evaluations, page 73). All analytes that had one or more detections above the screening value in soils, vadose zone water, or regional groundwater were carried to the next step. For groundwater, only the data collected between 2004 and 2008 were evaluated because groundwater has been sampled over many years and after examining some representative data for long-term trends, the time period between 2004 and 2008 was deemed to be most representative of current and recent conditions at the site and the most reliable in terms of quality control.
- Inorganic constituents that are naturally occurring were eliminated as COPCs. The basis for this determination included the site-specific background metals study (presented in Appendix F), the results of the literature and professional publications review, and an extensive geochemical evaluation on natural geochemistry and mineralogy of the Tularosa Basin (presented in Section 4.3.6, page 44). The site-specific background study was limited to the upper 10 feet of soils.

Site-specific background studies were not conducted for deeper soils, vadose zone water, or regional groundwater. Site-specific background studies were not conducted for deeper soils because only the upper 10 feet of soils are considered for potential exposure for human and ecological receptors for the risk assessment process.

Site-specific background values could not be calculated for the vadose zone water because its anthropogenic nature makes it impossible to apply traditional approaches to background determinations ~~because~~since there ~~is~~are neither published data nor other areas outside the facility from which reference data can be drawn. In addition, vadose zone water would likely not be present in undisturbed areas where background evaluations would be performed.

In lieu of a regional groundwater background study, an extensive geochemical evaluation of published documents regarding the natural geochemistry and mineralogy of the Tularosa Basin was conducted. Because of the high degree of variability for the mineralology within the Tularosa Basin, a statistically valid background study of the Regional Aquifer would be a complex and costly endeavor. The findings from the geochemical evaluation provide strong evidence to support conclusions regarding the naturally occurring inorganic constituents. Findings from the geochemical evaluation not only identified background conditions for inorganic constituents in vadose zone water and regional groundwater, but also helped to support and augment the findings from the background study conducted for soils.

As a result of the soil background and review of professional literature pertaining to naturally occurring geochemical conditions~~studies~~, two general classes of naturally occurring inorganic constituents were identified: a) those constituents that are naturally occurring and whose detected concentrations in the site media are within ranges considered to be representative of naturally occurring background conditions; and b) those constituents that are naturally occurring in native soils and have been solubilized and detected in deep soils, vadose zone water, and groundwater because of a change in redox conditions resulting from contact with high organic content water (including water affected by the ~~systemic~~Systemic diesel fuel release and wastewater from the leaky sewer system). A detailed discussion of the research findings is included in Section 4.3.6 (page 44).

Constituents that fall into the first class of naturally occurring inorganics include aluminum, barium, boron, chloride, fluoride, lithium, selenium, strontium, sulfate,

and vanadium. With the exception of fluoride, the occurrence of these constituents fall within the ranges considered representative of naturally occurring ~~background~~ conditions and they were eliminated as COPCs during this COPC selection process. Fluoride was not eliminated as a COPC because of the reported release at the Test Cell Lagoon (SWMU 145) and the storage of fluoride-containing wastes at the Fluorspar Tanks (SWMUs 33 and 34). Although the reported release at the Test Cell Lagoon may have resulted in a short-term localized increase in fluoride concentrations near the Test Cell Lagoon, current fluoride concentrations in vadose zone and regional groundwater near both of these areas are consistent with natural conditions.

Constituents that fall into the second class of naturally occurring inorganics (i.e., redox-affected inorganics) include arsenic, cobalt, iron, manganese, and nickel. As discussed previously, each of these constituents occurs naturally in the soil matrix and, under normal conditions, remains in the soil matrix. However, there is an overwhelming amount of published data indicating that these constituents become solubilized under reducing conditions. The occurrence of these constituents in groundwater at the HELSTF site is coincident with the current or past presence of high organic content water that would lead to reducing conditions. In addition, these constituents were not generally managed in the SWMU waste streams, supporting the conclusion that they originated from the naturally occurring soil matrix. Site-specific data for beryllium and cadmium suggest that these two constituents are also part of this class of redox-affected inorganics. However, there was not enough literature to support this determination; therefore, ~~the~~ beryllium and cadmium were retained as COPCs.

- Constituents were compared with the specific constituents or classes of constituents identified as having been managed at each SWMU. If a constituent was not one of the constituents or classes of constituents including degradation products associated with wastes managed at a SWMU, it was eliminated from further consideration.

  Examples of constituents eliminated as COPCs because they were not in waste streams managed by the SWMUs include explosives (2,4,6-trinitrotoluene, 2-nitrotoluene, hexahydro-trinitro-triazine [RDX], nitrobenzene, and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine [HMX]), and herbicides (aldrin, toxaphene, dibenzofuran, n-Nitroso-di-n-propylamine, and bromomethane). ARCADIS interviewed two long-time employees familiar with past operations at the HELSTF regarding possible use of explosives (Reynolds, pers. comm., 2009b; Tyree, pers. comm., 2009). According to both sources, explosives and solid rocket fuel

were never used in the HELSTF proper because of the risk they posed to the HELSTF equipment. The nearest location where targets were used, which would have involved use of explosives, was 750 to 800 meters north/northwest of the main LSTC building, in the Test Cell B area, which is still within the HELSTF boundaries, but not in the vicinity of the SWMUs discussed in this report and not in the vicinity of any of the detections of explosive constituents. Pesticides were also not known to be used or managed in waste streams at any of the SWMUs. In the instances of each of the explosive and pesticide constituents, their frequency of detection was generally very low and their distribution in the site samples was not indicative of a release from a SWMU.

The COPC selection process described above was used to determine whether constituents should be evaluated as part of the site characterization process. A table summarizing constituents and the final COPCs is provided as Table 6-1. The COPCs were used to determine whether a release had occurred from a SWMU and were then used to define the nature and extent of the release. In general, the nature and extent of COPCs in soils were delineated on a SWMU-by-SWMU basis because constituents are generally not mobile in soils once a release has occurred and the extent of the affected soils tends to be limited to the area in the immediate vicinity of the release. The nature and extent of constituents in soils is provided in the SWMU-by-SWMU discussions in Sections 6.2 through 6.24 (pages 101 through 349). Soil sampling locations and maps showing nature and extent of COPCs in soil are shown on Figures 6.2-1 through 6.21-3.

Comment [KG2]: Table needs QC; Also, check lines on headers in table (formatting)

In general, the nature and extent of COPCs in vadose zone water and regional groundwater could not be addressed on a SWMU-by-SWMU basis because the anthropogenic vadose zone water is a transport system that has resulted in an extremely complex distribution of constituents that does not always correspond well to the location of the SWMU. The distribution of constituents in groundwater is confounded by the changes in distribution of vadose zone water over time, the lack of a normal gradient in the vadose zone water, and the uncertainty as to the locations where vadose zone water connects to the regional groundwater. Because of this, COPC occurrence in vadose zone water and regional groundwater was evaluated on a more holistic basis, as discussed in Section 6.25 (page 351). Vadose zone and regional well locations used in the evaluations are shown on Figure 4.3-910.

As previously discussed, the COPC selection process described in this section was used for characterizing the nature and extent of releases from the SWMUs and ERAs. However, it is important to note that this process was *not* used for the HHRAs. To be

conservative, all of the data collected for the Phase I, II, and III RFI field activities were considered as COPCs in the HHRA and ERA and no constituents were screened out prior to beginning the risk assessment. A specific COPC selection process was used for the risk assessments and is described in detail in Section 5.4 (Risk Assessment Methods, page 79).

6.2 SWMUs 23 and 24 – Hazardous Waste Tanks at HELSTF

6.2.1 Unit Description

The hazardous waste tanks (SWMUs 23 and 24) were located on the northeastern exterior side of the Cleaning Facility (Building 26131) on a curbed concrete pad. SWMU 23 was a 5,000-gallon aboveground storage tank (AST) and SWMU 24 was a 2,500-gallon AST. The tanks were constructed of metal and lined with fiberglass.

6.2.2 Operational History

Between approximately 1981 and 1984, these two tanks were used to accumulate hazardous waste from the Cleaning Facility (Building 26131). ~~When used to contain hazardous waste from the Cleaning Facility, t~~The tanks received hazardous wastes containing phosphoric acid, sodium hydroxide, sodium carbonate, nitric acid, hydrofluoric acid, methyl ethyl ketone (MEK), isopropyl alcohol, and deionized water (A.T. Kearney, 1988). The waste in SWMUs 23 and 24 was periodically emptied and transferred to the NASA/WSMR Lagoons located on the west side of the San Andres Mountains, north of Organ. Permission was granted in March 1984 for the waste in these tanks to be disposed of in the evaporation tank (SWMU 90) located at the WSMR Hazardous Waste Disposal Facility.

At the time of the 1988 RFA, SWMU 23 was used for the storage of cleaning reagents (i.e., it was no longer used to store waste); it was used in this capacity until approximately 1989. SWMU 24 had been completely removed from service at the time of the 1988 RFA. As indicated in the July 1990 Ground-Water Quality Survey, both tanks had been moved to the surplus material storage area by 1990.

The potential COPCs associated with SWMUs 23 and 24 include spent/used solvents, acids, and detergents.

6.2.3 Regulatory History

The 1988 RFA stated that there was no history of a release from these two tanks during their operation, and no further investigation was conducted. In the 1988 RFA report, it was concluded that the release potential to surface water, air, soil, and groundwater was low because the tanks were constructed of metal lined with fiberglass and were situated in concrete curbed containment ~~(A.T. Kearney, 1988)~~. The RFA report also stated that there was no potential for release in 1988 because SWMU 24 had been removed and SWMU 23 was no longer used for waste handling (A.T. Kearney, 1988). The SWMUs were not included in the 1989 RCRA permit. However, they are listed on Table 4-1 of the current (December 2009) WSMR RCRA permit as SWMUs requiring corrective action. ~~However, the SWMUs have remained in Table A.2 of the Annual Unit Audit, indicating that NFA is appropriate.~~

6.2.4 Investigative History

There have been no previous subsurface investigations conducted at SWMUs 23 and 24~~. and T~~ there are no wells or borings specifically associated with these~~is~~ SWMUs. As indicated in the RFA report (A.T. Kearney, 1988) and Phase III RFI Work Plan (WTS, 2006), there was no history of release from these SWMUs. If any releases from these tanks had occurred ~~from these tanks~~, they could not be distinguished from those previously documented at SWMUs 142 (HELSTF Cleaning Facility [HCF] Sump) and 154 (HELSTF Systemic Diesel Spill Site). ~~As a result of these conditions~~Therefore, no further assessment of soil and groundwater conditions was proposed as part of the Phase III RFI for these SWMUs. However, some of the boring locations advanced as part of the RFI activities at SWMU 142 ~~(HELSTF Cleaning Facility [HCF] Sump)~~ and SWMU 147 (Decontamination Pad and Underground Holding ~~S~~Tank) were evaluated for soil conditions in the vicinity of SWMUs 23 and 24.

6.2.5 Nature and Extent of Contamination

~~There are no recorded releases from the two former ASTs, SWMUs 23 and 24.~~ The soil conditions in the vicinity of SWMUs 23 and 24 are evaluated from five borings installed nearby (within 35 feet) to the northeast and southeast for the purpose of delineating affected soils at nearby SWMUs 142 and 147. ~~These borings were advanced as part of RFI-related activities and were evaluated for this discussion.~~ The soil boring locations are shown on Figure 6.2-1, and a comprehensive data summary for soil is provided in Table 6-2~~-1 1 of Appendix D-2.~~

6.2.5.1 *VOCs~~Shallow Soil (0 to 10 ft bgs)~~*

As shown on Table 6-2, four samples were collected from shallow soil (• 10 ft bgs) in the vicinity of SWMUs 23 and 24. Soil samples were collected from depths greater than 10 ft bgs from the following borings in the vicinity of SWMUs 23 and 24 : ~~at sample locations of~~ 142B3, 147B1, CFW-01, CFW-02, and HLSF-SB-014 (Figure 6.2-1). ~~As shown on Table 6.2-1, Of the four samples (147B1, 5 and 10 ft bgs, and CFW-02, 3-5, and 8-10 ft bgs)~~ were collected from shallow soil (~~• 10 ft bgs)~~ in the vicinity of SWMUs 23 and 24. ~~, the only two analytes detected above their respective detection limits were bis(2-ethylhexyl)phthalate (BEHP) and arsenic. Table 6.2-1 provides a statistical summary of data for shallow soil and Table 6.2-2 provides a summary of exceedances of regulatory standards for shallow soil at SWMUs 23 and 24.~~

6.2.5.1.1 Shallow Soil (0 to 10 ft bgs)~~VOCs~~

No VOCs were detected in shallow soils (• 10 ft bgs) at this unit.

6.2.5.1.2 Deep Soil (Greater than 10 ft bgs)

The VOCs 1,1-dichloroethane (1,1-DCA), benzene, ethylbenzene, and xylenes were detected above the DAF 20 standard in deep soil. Since these constituents were not detected in shallow soils, their detections in deeper soils are not indicative of a release to the surface from aboveground tanks. The detections of the chlorinated hydrocarbon and the petroleum hydrocarbon constituents are associated with the underlying effects of the commingled releases from SWMU 142 and SWMU 154.

6.2.5.2 *Semivolatile Organic Compounds (SVOCs)*

6.2.5.2.1 Shallow Soil (0 to 10 ftbgs)

No SVOCs were detected above regulatory standards.~~BEHP was the only SVOC detected in shallow soils at this unit, and it was detected in only one sample, 147B1 (5 ft bgs), at 0.46 mg/kg. BEHP is a common laboratory artifact and the detection is likely attributable to laboratory contamination. Additionally, it should be noted that its detection is isolated to one sample(s) collected at this SWMU and it was not a constituent managed in the waste stream at this SWMU. Therefore, the detection of BEHP is not being attributable to soil conditions and it is not considered a COPC.~~

6.2.5.2.2 Deep Soil (Greater than 10 ft bgs)

Naphthalene was the only SVOC detected above its DAF 20 standard. Since naphthalene was not detected in shallow soil, its occurrence in deep soil is not indicative of a release from tanks on the ground surface. The presence of naphthalene in deep soil is attributable to effects of the release from SWMU 154.

6.2.5.3 *Other Parameters*

~~6.2.5.1.2~~6.2.5.3.1 Shallow Soil (0 to 10 ft bgs)

A low concentration of TPH were detected at 21 mg/kg in one (147B1 5 ft bgs) of the two shallow soil samples designated for this analysis. There are no applicable TPH regulatory standards that apply to the HELSTF. This low concentration of TPH is not indicative of a release.

~~. However, samples tested for TPH were also tested for full suites of VOCs and SVOCs that would comprise the TPH. With the exception of the BEHP discussed above, none of the VOC or SVOCs were detected at concentrations above screening levels, confirming that the detected TPH does not represent a risk to potential receptors.~~

6.2.5.3.2 Deep Soil (Greater than 10 ft bgs)

Elevated concentrations of TPH were detected in deep soil samples designated for this analysis. As stated previously, there are no applicable regulatory standards for TPH in soil. Occurrences of TPH in this area are attributable to the release from SWMU 154 and are not indicative of a release to the surface from the aboveground storage tanks, SWMUs 23 and 24.

6.2.5.4 *Metals*

~~6.2.5.1.3~~6.2.5.4.1 Shallow Soil (0 to 10 ft bgs)

Arsenic was the only metal detected above a regulatory standard in samples collected from shallow soil (• 10 ft bgs) near SWMUs 23 and 24. Arsenic was detected above the DAF 20 in three of the four shallow soil samples designated for this analysis. ~~The~~

~~arsenic detections do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained arsenic.~~ As described previously, arsenic detections are attributable to redox-related conditions ~~naturally occurring conditions~~ existing at the HELSTF.

6.2.5.4.2 Deep Soil (Greater than 10 ft bgs)

Arsenic was the only metal detected at concentrations above the DAF 20 standard. The arsenic exceedances of the DAF 20 value do not represent releases of waste constituents from these SWMUs because there were no wastes generated or managed at the HELSTF that contained arsenic . As described previously, arsenic detections are attributable redox-related ~~naturally occurring~~ conditions existing at the HELSTF.

~~6.2.5.1.4~~6.2.5.4.3 ~~Shallow~~ Soil Summary

In summary, there were no COPCs detected in shallow soils in the vicinity of SWMUs 23 and 24. Although 1,1-DCA, benzene, ethylbenzene, xylenes, naphthalene, and TPH were detected in deep soil samples, these detections are most likely attributable to releases from the SWMUs 142 and 154. Because there is no information that there were ever releases from SWMUs 23 and 24 and since none of these constituents were detected in shallow soils, there is no indication that there have been releases of COPCs from SWMUs 23 and 24.

~~*6.2.5.2 Deep Soil (Greater than 10 ft bgs)*~~

~~Soil samples were collected from depths greater than 10 ft bgs from the following borings in the vicinity of SWMUs 23 and 24: 142B3, 147B1, CFW-01, CFW-02, and HLSF-SB-014 (Figure 6.2-1). Thirteen VOCs, 14 SVOCs, TPH, and 4 miscellaneous inorganic constituents were detected above laboratory reporting limits in deep soils from these borings. Table 6.2-3 provides a statistical summary of data for deep soil and Table 6.2-4 provides a summary of exceedances of regulatory standards for deep soil at SWMUs 23 and 24. Table 6.2-11 in Appendix D-2 provides a comprehensive summary of all soil data for SWMUs 23 and 24.~~

~~6.2.5.2.1 VOCs~~

~~The VOCs 1,1-dichloroethane (1,1-DCA), benzene, ethylbenzene, and xylenes were detected above the DAF 20 standard in deep soil. Since these constituents were not detected in shallow soils, their detections in deeper soils are not indicative of a release~~

to the surface from aboveground tanks. The detections of the chlorinated hydrocarbon and the petroleum hydrocarbon constituents are associated with the underlying effects of the commingled releases from SWMU 142 and SWMU 154.

The following VOCs were detected in deep soil (>10 ft bgs): 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethane (1,1-DCA), acetone, benzene, carbon disulfide, ethylbenzene, isopropylbenzene, naphthalene, n-butylbenzene, n-propylbenzene, sec-butylbenzene, toluene, and total xylenes. With the exception of carbon disulfide, 1,1-DCA, 1,1,1-TCA, and toluene, these constituents were detected in deep soil at concentrations above their respective NMED DAF 1 values.

1,1,1-TCA was detected in 10 of 41 deep soil samples designated for this analysis and 1,1-DCA was detected in 11 of 41 deep soil samples in the vicinity of SWMUs 23 and 24. As stated previously, these detections did not exceed the NMED DAF 1 screening criteria. Because these constituents were not detected in shallow soils, their detections in deeper soils are not indicative of a release to the surface from aboveground tanks. The detections of these chlorinated hydrocarbons are likely associated with the underlying effects of the release from SWMU 142.

Acetone was detected in 10 of the 41 deep soil samples designated for this analysis near SWMUs 23 and 24. Because acetone was not detected in shallow soils in this area, these deep detections are not indicative of a release to the surface from aboveground tanks, SWMUs 23 and 24. These acetone detections are most likely attributable to releases from the Cleaning Facility Sump (SWMU 142). Therefore, acetone is not considered a COPC associated with SWMUs 23 and 24.

Benzene, ethylbenzene, isopropylbenzene, naphthalene, n-butylbenzene, n-propylbenzene, sec-butylbenzene, toluene, and total xylenes are not COPCs associated with the wastes stored in SWMUs 23 and 24. These detections in deep soils are associated with the underlying effects of the Systemic Diesel Spill (SWMU 154).

6.2.5.2.2 SVOCs

Naphthalene was the only SVOC detected above its DAF 20 standard. Since naphthalene was not detected in shallow soil, its occurrence in deep soil is not indicative of a release from tanks on the ground surface. The following five SVOCs were detected in the deep soil (>10 ft bgs) above their respective NMED DAF 1 screening values: 1,2,4-trimethylbenzene (1,2,4-TMB), 1,3,5-trimethylbenzene (1,3,5-

TMB), dibenzofuran, fluorene, and n-nitrosodiphenylamine. As indicated in Table 6.1-1 (Summary of COPC Selection), n-nitrosodiphenylamine is not a COPC associated with any SWMU. The remaining SVOCs are not associated with SWMUs 23 and 24. They The presence of naphthalene are in deep soil is attributable to effects of the release from the Systemic Diesel Spill (SWMU 154).

6.2.5.2.3 Other Parameters

Elevated concentrations of TPH were detected in all of the ten deep soil samples designated for this analysis. As stated previously, there are no applicable regulatory standards for TPH in soil. Occurences of TPH in this area are attributable to the release from SWMU 154 and is not indicative of a release to the surface from the aboveground storage tanks, SWMUs 23 and 24.

Cyanide, sodium, phosphorus, sulfide, and organic carbon were also detected in deep soils in the vicinity of SWMUs 23 and 24. With the exception of cyanide, all of these constituents are considered naturally occurring. Cyanide was detected in three of the six deep soil sample designated for this analysis. The concentrations of cyanide were very low (0.2 to 0.53 mg/kg) and there is no evidence that cyanide was associated with operations at the HELSTF. The cyanide detections do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained cyanide.

6.2.5.2.4 Metals

Nine metals (arsenic, barium, chromium, copper, hexavalent chromium, lead, nickel, vanadium, and zinc) were detected in deep soils in the vicinity of SWMUs 23 and 24. Of these, only arsenic and hexavalent chromium detections exceeded their respective NMED DAF 1 screening values.

Arsenic was the only metal detected at concentrations above the DAF 20 standard. The arsenic exceedances of the DAF 20 value, barium, and vanadium detections do not represent releases of waste constituents from these SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained arsenic these constituents. As described previously, arsenic, barium, and vanadium detections are attributable to naturally occurring conditions existing at the HELSTF.

Hexavalent chromium was detected in 4 of the 26 deep soil samples designated for this analysis. All four detections were above the NMED DAF 1 standard of 2.1 mg/kg and occurred at only one boring location, CFW-02 (43 to 45, 48 to 50, 53 to 55, and

58 to 60 ft bgs). Because hexavalent chromium was not detected in shallow soils in this area, these deep detections are not indicative of a release to the surface from aboveground tanks, SWMUs 23 and 24.

6.2.5.2.5 Deep Soil Summary

Although 1,1-DCA, benzene, ethylbenzene, xylenes, naphthalene, and TPH chlorinated VOCs, acetone, and hexavalent chromium were detected in deep soil samples, these detections are most likely attributable to releases from the Cleaning Facility Sump (SWMUs 142) and 154. Since there is no information that there were ever releases from SWMUs 23 and 24 and since none of these constituents were detected in shallow soils, there is no indication that Therefore, there have been no releases of COPCs from SWMUs 23 and 24.

6.2.6 Human Health Risk Assessment Findings

An HHRA was not conducted for SWMUs 23 and 24 because there have not been any site-specific investigations conducted at these SWMUs. The data used to evaluate conditions surrounding this SWMU were collected as part of assessments conducted to investigate SWMUs 142 and 147. The results of the HHRAs conducted at SWMUs 142 and 147 are provided under Sections 6.12.6 (page 210) and 6.17.6 (page 279), respectively.

6.2.7 Ecological Risk Assessment Findings

An ERA was not conducted for SWMUs 23 and 24 because there have not been any site-specific investigations conducted at these SWMUs. The data used to evaluate conditions surrounding these SWMUs were collected as part of assessments conducted to investigate SWMUs 142 and 147. The results of the ERAs conducted at SWMUs 142 and 147 are provided under Sections 6.12.7 (page 213) and 6.17.7 (page 281), respectively.

6.2.8 Conclusions and Recommendations

SWMUs 23 and 24 were aboveground fiberglass-lined metal tanks used to store hazardous wastes from the Cleaning Facility between 1981 and 1984. These wastes included spent/used solvents, acids, and detergents. From 1984 to 1988, SWMU 23 was used to store cleaning reagents (and no longer stored wastes); by 1988, SWMU 24 had been removed from service. There were no reported releases from

SWMUs 23 and 24; they were aboveground tanks located within a curbed concrete pad, and they were in service as hazardous waste tanks for only 3 years, more than 25 years ago. There were no impacts to shallow soils in the vicinity of these tanks and, therefore, no evidence of a surficial release in this area.

Soils and vadose zone water beneath and surrounding the Cleaning Facility have been impacted by documented releases from SWMU 142 (HELSTF Cleaning Facility Sump) and SWMU 154 (HELSTF Systemic Diesel Spill). As discussed in Section 6.25.5.1 (LNAPL, page 364), the areal extent of the diesel fuel impacts in the subsurface currently includes areas beneath SWMUs 23 and 24 (Hazardous Waste Tanks at HELSTF), 25 (Waste Accumulation Area), 26 (Vapor Recovery Unit at HELSTF), 142 (HELSTF Cleaning Facility Sump), and 147 (Decontamination Pad & Underground Holding Tank~~and Underground Tank~~). Downgradient regional groundwater has also been impacted by these releases. ~~Vadose Zone Wells CFW-01 and CFW-02 are located closest to the former hazardous waste tanks (SWMUs 23 and 24). Depth to water in these wells is approximately 45.5 ft bgs. Data collected from CFW-01 between 2004 and 2008 do not indicate exceedances of groundwater standards for any of the constituents that were detected above regulatory standards in deep soils in the vicinity of SWMUs 23 and 24. CFW-02 has not been sampled since 1993.~~

Impacts to deep soil, vadose zone water, and/or regional groundwater are not attributable to SWMUs 23 and 24 and are being addressed under SWMUs 142 and 154. Based upon these conditions, these SWMUs are eligible for NFA and should be removed from the RCRA process.

6.3 SWMU 25 – Waste Accumulation Area

6.3.1 Unit Description

SWMU 25 is an asphalt-paved, fenced area, which is 50 feet by 100 feet, and ~~-~~located northwest of and extending to the southern edge of the Cleaning Facility (SWMU 142) in the HELSTF. ~~The area of SWMU 25 measures 50 feet by 100 feet.~~ The accumulation area received spent degreasing solvents that contained 1,1,1-TCA and waste oils from the Cleaning Facility (A.T. Kearney, 1988).

6.3.2 Operational History

This area was used for storing 55-gallon drums containing spent degreasing solvents. Drums were staged on pallets and wastes were reported to have been stored for less

than 90 days. Operation of this area began in 1984 and continued through 1990. During 2001 and 2002, the area was used as a sorting yard for wastes pending characterization and a storage area for nonhazardous waste.

The potential contaminants associated with SWMU 25 include those constituents associated with spent degreasing solvents. During the Phase III RFI, a soil boring was advanced in soil adjacent to the western edge of the concrete slab comprising SWMU 25 to address a reported historical chromate or chromate additive spill. Thus, the COPCs at that Phase III RFI boring location included chromium, hexavalent chromium, and zinc. Due to its proximity to the HELSTF Systemic Diesel Spill Site (SWMU 154), TPH and VOCs were also analyzed for soil samples collected during the Phase III RFI.

6.3.3 Regulatory History

The visual site inspection and the 1988 RFA concluded that there was no history of a release from this site (A.T. Kearney, 1988). Therefore, SWMU 25 was subsequently left out of the HSWA operating permit dated October 24, 1989. However, SWMU 25 is listed on the current RCRA permit as a Hazardous Waste Tank at HELSTF that requires corrective action. It is believed that the unit description on the current permit for SWMU 25 is erroneous, as it has always been referred to as a waste accumulation area and there are no records indicating that this SWMU was a hazardous waste tank. ~~This site is listed in the Annual Unit Audit as needing no further action.~~

A leak from a drum containing chromate was reported in the 1990 Ground-Water Quality Survey. The survey report stated that the soil adjacent to the west side of SWMU 25 had been contaminated by the chromate release between 1984 and 1986. The 1990 Ground-Water Quality Survey report recommended soil sampling at this location. Documentation pertaining to the spill incident, response effort, or additional sampling activities was not available in site file records. ~~The site has remained in Table A.2 of the Annual Unit Audit, indicating that the site is still eligible for NFA.~~

6.3.4 Investigative History

No Phase I or II RFI activities were conducted at SWMU 25. In response to the reported spill on the west side of SWMU 25, one soil boring was advanced in the vicinity of the reported chromate spill as part of the Phase III RFI field investigation.

Phase III RFI

As part of the Phase III RFI, a soil boring (HLSF-SB-010) was drilled to a depth of 50 ft bgs in the vicinity of the reported chromate spill. Although the Phase III RFI Work Plan (WTS, 2006) stated that a surface sample was to be collected from this boring, the Phase III Report (WTS, 2008) states that a surface sample was not collected due to the asphalt and/or cement covering over the site. Samples were collected from every 10 feet to the total depth of the boring. The soil samples were analyzed for chromium, hexavalent chromium, zinc, TPH-gasoline range organics (GRO), TPH-diesel range organics (DRO), VOCs, and TOC.

Groundwater was also sampled from three nearby monitoring wells (Vadose Zone Well DRW-08 and Regional Wells DRW-17 and HMW-65) for selected metals, water quality parameters, VOCs, SVOCs, TPH, and TOC analysis. Vadose Zone Well CFW-03 was also to be sampled, but it was dry during the Phase III RFI sampling event.

Soil results did not indicate any detections of constituents above regulatory action levels. Water from Vadose Zone Well DRW-08 had detections of total chromium above the NMED groundwater standard; dissolved chromium was below the NMED groundwater standard (Table 6-21~~.25-X~~). In addition, total and dissolved molybdenum exceeded the NMED Tapwater standard in 2006 in vadose zone water from DRW-06; the well has not been sampled for molybdenum since 2006. DRW-08 is located over approximately 40 feet south of the reported chromate spill site at SWMU 25. Because there were no impacts to soil at SWMU 25, the chromium detected in water from DRW-08 is not a result of a release at SWMU 25.~~Several other metals and chlorinated VOCs were also detected in vadose zone water from DRW-08, but the concentrations of these constituents were well below their respective regulatory stan~~

No VOCs or SVOCs were detected in groundwater from Regional Well HMW-65, and no metals were detected above their respective regulatory standards. Regional groundwater from DRW-17 had chromium concentrations detected above the NMED groundwater standard in 2007, 2008, and 2009, hexavalent chromium above the NMED tapwater standard in 2009, and TCE above the EPA MCL in 2007, 2008 and 2009 (Table 6-22~~6.25-X~~). DRW-17 is located north of the reported chromate spill and immediately west of the remaining SWMU 25 area. Since there was no evidence of a release to soil at SMWU 25 and since regional groundwater flows southeasterly, the source of the impacts at DRW-17 would not be related to a release from SWMU 25. Evaluations of soil and groundwater detections are provided below.~~Vanadium was the only metal detected in groundwater from HMW-65, and its concentration was well below the NMED Tapwater standard.Data collected during subsequent sampling~~

~~events in 2007 and 2008 indicate that chromium and TCE concentrations have increased in groundwater from DRW-17 to levels exceeding the NMED groundwater standard. Groundwater data collected from Regional Wells DRW-17 and HMW-65 indicate detections of metals and water quality parameters. Based on the location of Regional Wells DRW-17 and HMW-65 relative to SWMU 25 (west and southwest, respectively) and the known southeasterly groundwater flow direction in the Regional Aquifer, impacts to the Regional Aquifer in this area are associated with another source described under Section 6.26 (page 38) (off-site source of TCE, 1,1-DCE, and chromium) and are not attributable to SWMU 25. Evaluations of soil and groundwater detections are provided below.~~

6.3.5 Nature and Extent of Contamination in Soil

There was only one release that was reported during the operation of SWMU 25. This release consisted of the chromate spill that was referenced in the 1990 Groundwater Survey. ~~The area is concrete-paved and wastes were stored in containers on pallets.~~ Three soil boring locations that were advanced as part of all RFI-related activities were evaluated. The soil borings that were used for this evaluation are associated with SWMU 25 (HLSF-SB-010), advanced to investigate the reported historical chromate spill on soil adjacent to the concrete pad, and SWMU 154 (Systemic Diesel Spill) (154BG and DRW-17).

The soil boring locations are shown on Figure 6.3-1, and ~~,and a comprehensive data summary for soil is provided in Table 2 of Appendix D-2. Table 6.3-1 provides a statistical summary of data for shallow soil and~~ Table 6.~~3~~-3 provides a summary of results for ~~exceedances of regulatory standards for shallow~~ soil at SWMU 25.

As shown on Table 6-3, one shallow soil sample (154BG, 2 ft bgs) was collected in the vicinity of SWMU 25. There were no constituents detected in the shallow soil. Soil samples were collected from depths greater than 10 ft bgs from borings DRW-17 and HLSF-SB-10 in the vicinity of SWMU 25.

6.3.5.1 *VOCs~~Shallow Soil (0 to 10 ft bgs)~~*

6.3.5.1.1 Shallow Soil (0 to 10 ft bgs)

No VOCs were detected in shallow soils (• 10 ft bgs) at this unit.~~One shallow soil sample (154BG, 2 ft bgs) was collected in the vicinity of SWMU 25. There were no~~

~~constituents detected in the shallow soil. and, therefore, there were no exceedances of any regulatory standards.~~

~~6.3.5.1.2 VOCs~~

~~No VOCs were detected in shallow soils (• 10 ft bgs) at this unit.~~

~~6.3.5.1.3~~6.3.5.1.2 Deep Soils (Greater than 10 ft bgs)~~SVOCs~~

There were no detections of VOCs in deep soil at or near SWMU 25 that exceeded the regulatory standards~~No SVOCs were detected in shallow soils (• 10 ft bgs) at this unit.~~

6.3.5.2 *SVOCs*

6.3.5.2.1 Shallow Soil (0 to 10 ft bgs)

No VOCs were detected in shallow soils (• 10 ft bgs) at this unit.

6.3.5.2.2 Deep Soil (Greater than 10 ft bgs)

The only SVOC detected in deep soil in the vicinity of SWMU 25 above a regulatory standard was naphthalene, at HLSF-SB-010 (20 to 22 ft bgs). The detected concentration exceeded the NMED DAF 20~~1~~ screening value of 0.0839 mg/kg. This naphthalene occurrence is likely associated with the diesel spill from SWMU 154.

6.3.5.3 *Other Parameters*

~~6.3.5.1.4~~6.3.5.3.1 Shallow Soil (0 to 10 ft bgs)

Shallow soil sample 154BG was analyzed for TPH, but no TPH were detected.

6.3.5.3.2 Deep Soil (Greater than 10 ft bgs)

TPH-DRO and TPH-GRO were detected at 67.4 and 24.3 mg/kg, respectively, at one location, HLSF-SB-010 (20 to 22 ft bgs). There are no applicable standards for TPH. However, because the samples were also analyzed for VOCs and SVOCs, specific constituents comprising the TPH were analyzed and compared to their respective standards, as discussed in the previous two subsections. As stated, only one detection of naphthalene exceeded a regulatory standard. The TPH and naphthalene

occurrences in deep soil at SWMU 25 are attributable to the diesel spill from SWMU 154.

6.3.5.4 *Metals*

~~6.3.5.1.5~~6.3.5.4.1 Shallow Soil (0 to 10 ft bgs)

No metals were detected in shallow soils (• 10 ft bgs) at this unit.

6.3.5.4.2 Deep Soil (Greater than 10 ft bgs)

There were no metals detected above regulatory standards in deep soil in the vicinity of SWMU 25.

~~6.3.5.2~~6.3.5.5 ~~*Shallow*~~ *Soil Summary*

In summary, none of the constituents analyzed were detected in shallow soils in the vicinity of SWMU 25. The~~re was~~ only ~~one~~ release that was reported during the operation of SWMU 25 was ~~-~~the chromate spill that was referenced in the 1990 Groundwater Survey. The area is concrete-paved and wastes were stored in containers on pallets situated on top of the concrete pad. None of the chromium detections at HLSF-SB-010 exceeded regulatory standards. The only constituent detected above the NMED DAF 20 screening value was naphthalene, which was detected in only one deep soil sample from one location (HLSF-SB-010, 20-22 ft bgs). Its absence in shallow soils indicates that the occurrence in deep soils is not associated with a release from SWMU 25.

This naphthalene exceedance is isolated and has been delineated. In addition, naphthalene has not been detected in water from nearby Vadose Zone Well DRW-08. As discussed in Section 6.25.5.1 (LNAPL, page 364), the areal extent of the diesel fuel impacts in the subsurface currently includes areas beneath SWMUs 23 and 24 (Hazardous Waste Tanks at HELSTF), 25 (Waste Accumulation Area), 26 (Vapor Recovery Unit at HELSTF), 142 (HELSTF Cleaning Facility Sump), and 147 (Decontamination Pad & Underground Holding Tank). Based upon this condition, the isolated detection of naphthalene in deep soil is not attributed to SWMU 25, and is likely attributable to the release from SWMU 154.

Regional Well DRW-17 is located adjacent to and west-southwest of SWMU 25. Groundwater from DRW-17 is impacted by chromium, hexavalent chromium, and TCE.

These detections in the regional groundwater are upgradient of the reported chromate spill at SWMU 25 and the storage area comprising SWMU 25.

6.3.5.3 *Deep Soil (Greater than 10 ft bgs)*

Soil samples were collected from depths greater than 10 ft bgs from the following borings in the vicinity of SWMU 25: borings DRW-17 and HLSF-SB-10 in the vicinity of SWMU 25. A summary of the results is included in Table 6.3-1. Four VOCs (isopropylbenzene, naphthalene, n-butylbenzene, and sec-butylbenzene), one SVOC (1,2,4-trimethylbenzene [TMB]), TPH-DRO, TPH-GRO, and two metals (chromium and zinc) were detected above laboratory reporting limits. Chromium and zinc were present in all of the soil samples collected from HLSF-SB-010. The organic constituents were identified in only the 20- to 22-foot sample from HLSF-SB-010. Table 6.3-3 provides a statistical summary of data for shallow soil and Table 6.3-4 provides a summary of exceedances of regulatory standards for deep soil at SWMU 25. Table 2 of Appendix D-2 provides a comprehensive summary of all of the SWMU 25 soil results.

6.3.5.3.1 VOCs

There were no detections of VOCs in deep soil at or near SWMU 25 that exceeded the regulatory standards

There was only one detection of naphthalene (0.159 mg/kg and 0.0948 mg/kg in the duplicated sample) at HLSF-SB-010 (20 to 22 ft bgs), and it exceeded the NMED DAF 1 screening value (0.0197 mg/kg). Naphthalene was not detected in the deeper samples from this boring. The DAF 1 exceedance for naphthalene is isolated and has been delineated in this area (Figure 6.3-2). Detections of isopropylbenzene, n-butylbenzene, and sec-butylbenzene in Boring HLSF-SB-010 did not exceed their respective NMED DAF 1 screening values.

6.3.5.3.2 SVOCs

The only SVOC detected in deep soil in the vicinity of SWMU 25 above a regulatory standard was naphthalene was 1,2,4-TMB, at HLSF-SB-010 (20 to 22 ft bgs). The detected concentration did not exceeded the NMED DAF 201 screening value of 0.0839 mg/kg.

6.3.5.3.3 Other Parameters

TPH-DRO and TPH-GRO were detected at 67.4 and 24.3 mg/kg, respectively, at one location, HLSF-SB-010 (20 to 22 ft bgs). There are no applicable standards for TPH. However, because the samples were also analyzed for VOCs and SVOCs, specific constituents comprising the TPH were analyzed and compared to their respective standards, as discussed in the previous two subsections. As stated, only one detection of naphthalene exceeded a regulatory standard.

6.3.5.3.4 Metals

There were no metals detected above regulatory standards in deep soil in the vicinity of SWMU 25.

Chromium and zinc were detected in deep soil from HLSF-SB-010 (10 to 11, 20 to 22, 30 to 31, 40 to 41, and 49 to 50 ft bgs). None of the detections exceeded their respective NMED DAF 1 screening values.

6.3.5.3.5 Deep Soil Summary

There was only one release that was reported during the operation of SWMU 25. This release consisted ofwas the chromate spill that was referenced in the 1990 Groundwater Survey. The area is concrete-paved and wastes were stored in containers on pallets situated on top of the concrete pad. None of the chromium detections at HLSF-SB-010 exceeded regulatory standards. The only constituent detected above the NMED DAF 120 screening value was naphthalene, which was detected in only one deep soil sample from one location (HLSF-SB-010, 20-22 ft bgs). Its absence in shallow soils indicates that the occurrence in deep soils is not associated with a release from SWMU 25.

This naphthalene exceedance is isolated and has been delineated. In addition, naphthalene has not been detected in water from nearby Vadose Zone Well DRW-08. As discussed in Section 6.25.5.1 (LNAPL, page 292), the areal extent of the diesel fuel impacts in the subsurface currently includes areas beneath SWMUs 23 and 24 (Hazardous Waste Tanks at HELSTF), 25 (Waste Accumulation Area), 26 (Vapor Recovery Unit at HELSTF), 142 (HELSTF Cleaning Facility Sump), and 147 (Decontamination Pad & Underground Holding Tankand Underground Tank). Based upon this condition, the isolated detection of naphthalene in deep soil is not attributed to SWMU 25, and is most likely attributable to the release from SWMU 154.

~~Regional Well DRW-17 is located adjacent to and west-southwest of SWMU 25. Groundwater from DRW-17 is impacted by chromium, hexavalent chromium, and TCE. These detections in the regional groundwater are upgradient of the reported chromate spill at SWMU 25 and the storage area comprising SWMU 25.~~

6.3.6 Human Health Risk Assessment

Data collected during site characterization activities during the RFIs were used in the evaluation of risk to human health. A description of the risk assessment methodologies and results is provided on page 63 of Appendix E.

Only one soil boring (HLSF-SB-010) was advanced at SWMU 25 to evaluate potential impacts to soil from an historical chromate spill west of the concrete pad. As indicated in the HHRA for SWMU 25, no surface soil (0 to 2 ft bgs) or combined surface and subsurface soil (0 to 10 ft bgs) data were required to be collected for the Phase I, II, or III RFI investigations. Therefore, any exposure to soil at SWMU 25 by site workers or future residents is not expected to represent an exposure concern.

All detected VOCs in total soil (i.e., vadose zone) were selected as COPCs for the future vapor intrusion evaluation because there are no NMED or USEPA soil screening levels that are protective of the vapor intrusion pathway. As summarized in Appendix E, the total ELCR values for the future vapor intrusion exposure pathway for the site worker scenario and for the residential scenario are within the acceptable target risk range of 10^{-6} to 10^{-4} for carcinogenic effects. The total HI values for the future vapor intrusion exposure pathway for the site worker scenario and for the residential scenario are below the benchmark of 1 for non-cancer hazard, indicating adverse non-carcinogenic effects are unlikely to occur.

In summary, the HHRA for SWMU 25 indicates that current and future industrial use of the site would result in potential exposures that are within or below the regulatory benchmarks for cancer risks and non-cancer hazards. The evaluation also indicates that potential ~~potential~~ hypothetical future residential redevelopment of the site would result in potential exposures that are within or below the regulatory benchmarks for cancer risks and non-cancer hazards. Based on these results, additional risk assessment is not warranted for SWMU 25.

6.3.7 Ecological Risk Assessment Findings

No significant terrestrial habitat occurs within SWMU 25. The entire site is fenced and covered with asphalt. Due to its location within an active testing facility and its current landcover (i.e., asphalt), SWMU 25 does not provide any significant habitat for ecological receptors and there are no complete exposure pathways to potentially affected media (i.e., soil) under current conditions. As described in the ERA presented on page 63 of Appendix E, surface soil and combined surface and subsurface soil samples were not required to be collected at SWMU 25 as part of the Phase I, II, or III RFI investigations. Therefore, no COPECs were identified for the site indicating that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in the soil. Therefore, no further ecological evaluation at SWMU 25 is warranted.

6.3.8 Conclusions and Recommendations

There were no COPC exceedances of the SSLs for residential soil at SWMU 25. Only one naphthalene occurrence exceeded the DAF 20. This exceedance has been delineated and is likely associated with the release from SWMU 154. The HHRA for SWMU 25 indicates that current and future industrial use of the site would result in potential exposures that are within or below the regulatory benchmarks for cancer risks and non-cancer hazards. The evaluation also indicates that potential future residential redevelopment of the site would result in potential exposures that are within or below the regulatory benchmarks for cancer risks and non-cancer hazards. Based on these results, additional risk assessment is not warranted for SWMU 25. Also, based on the lack of habitat for ecological receptors and the fact that there are no complete exposure pathways to potentially affected media, no further ecological evaluation at SWMU 25 is warranted.

~~A SLERA was completed for SWMU 25 to evaluate subsurface soil for ecological receptors. The results of the SLERA indicate there is adequate information to conclude that there are no significant current exposures to soil and future adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in the soil. Therefore, no further ecological evaluation at SWMU 25 is warranted.~~There are no environmental impacts associated with SWMU 25 as a result of historical site activities and no restrictions need to be applied to current or potential future land use at the site. Accordingly, the site is recommended for NFA and closeout of the RCRA process.

6.4 SWMU 26 – Vapor Recovery Unit at HELSTF

6.4.1 Unit Description

SWMU 26 is an inactive vapor recovery unit constructed of plate metal, fiberglass, and Plexiglas, partially located inside the Cleaning Facility and partially located on a concrete pad in an asphalt-paved area on the south side of the Cleaning Facility (Building 26131). SWMU 26 uses a water scrubbing technique to remove vapors from the cleaning baths located in the gross cleaning room inside the Cleaning Facility, which contained sodium hydroxide, phosphoric acid, MEK, and isopropyl alcohol.

6.4.2 Operational History

The original vapor recovery system operated from approximately 1984 to 1998, when it was replaced with a similar unit that was in operation until April 2009. The unit operations ceased when the chemical laser operations were discontinued at the HELSTF. As previously described, the unit was operated to remove vapors from cleaning water bath solutions inside the Cleaning Facility. The spent scrubber water was sent to the Chemical Waste Tanks (SWMUs 31 and 32) when they were in operation and the vapors were vented to the atmosphere. After the chemical waste tanks were taken out of service, the scrubbing solution was drummed and transferred to a permitted waste management facility (Tyree, personal comm., 2009).

The potential contaminants associated with SWMU 26 include those constituents associated with solvents, sodium hydroxide, phosphoric acid, isopropyl alcohol, and MEK.

6.4.3 Regulatory History

The 1988 RFA report indicated that there were no documented releases from this unit, but and no evidence of a release was noted based on the visual site inspection. The unit was reported to be well maintained. The RFA report stated that the release potential to soil, groundwater, surface water, and subsurface gas was low based on the fact that the unit is above ground and located on a concrete pad in a paved area (A.T. Kearney, 1988). However, the SWMU was listed as an Appendix II site in the 1989 HSWA operating permit, requiring further investigation. SWMU 26 is listed in the current (December 2009) WSMR RCRA permit as a unit requiring corrective action.

6.4.4 Investigative History

No investigation of SWMU 26 was conducted during the Phase I or II RFIs. The approved RFI Work Plan for the Appendix II and III sites stated that no sampling and analysis of this unit was indicated. The work plan stated that liquid wastes weare generated in the unit and collected inside the building. These wastes were drummed and stored under permit at another location. The airborne VOCs scavenged from the building by this unit weare vented to the atmosphere. The work plan further stated that the grounds near the building were to be investigated as part of a future action involving the Systemic Ddiesel Ffuel ~~release~~ Spill (SWMU 154) (EDGe Group, 1991a). No subsequent investigations specifically targeted this SWMU.~~; however, it remains on the Annual Unit Audit as requiring corrective action.~~ SWMU 26 is underlain by impacted media resulting from commingled releases from two other SWMUs (142 and 154) and any contamination from this unit would be assessed during the other SWMU investigations.

No Phase III activities were proposed for the SWMU. There has been no history of release associated with this SWMU. As indicated in the Phase III RFI work plan, additional sampling at this location would not likely confirm or refute a release from this location because the unit overlies areas impacted by releases from SWMUs 142 and 154~~ where impacts have been identified~~.

6.4.5 Nature and Extent of Contamination

~~It should be noted that the portion of the Vapor Recovery Unit (SWMU 26) containing the scrubber liquids was located inside the Cleaning Facility building. The liquids were removed from the unit, drummed, and transferred to a permitted waste management facility. The only portion of the unit located outside of the building was the fan and vent stack where captured vapors were vented to the atmosphere. There have been no reported releases from this unit.~~

No borings have been installed at SWMU 26; however, four borings installed within approximately 40 feet of the SWMU to the west, southwest, and southeast that were initially advanced to delineate affected soils at nearby SWMUs 142 and 147 were used to evaluate soil conditions in the vicinity of SWMU 26 (Figure 6.4-1). ~~A table presenting all analytical data for the evaluation of this SWMU is presented in Table 3 of Appendix D-2. Table 6.4-1 provides a statistical summary of data for shallow soil and~~ Table 6-4~~6.4-1~~2 provides a summary of results for soil in the vicinity of SWMU 26. ~~of exceedances of regulatory standards for shallow soil.~~ Shallow soil samples were

collected from two borings (CFW-04 and HCF-01) in the vicinity of SWMU 26. Four soil boring locations were evaluated in the vicinity of SWMU 26 where samples deeper than 10 ft bgs were collected (142B1, CFW-04, HCF-01, and HLSF-SB-019).

6.4.5.1 *VOCs~~Shallow Soil (0 to 10 ft bgs)~~*

Shallow soil samples were collected from two borings (CFW-04 and HCF-01) in the vicinity of SWMU 26.

6.4.5.1.1 Shallow Soil (0 to 10 ft bgs)~~VOCs~~

No VOCs were detected above regulatory criteria in shallow soil in the vicinity of SWMU 26.~~Total xylenes were the only VOCs detected in shallow soil (• 10 ft bgs) in the vicinity of SWMU 26. Xylenes were detected in only one shallow soil sample (CFW-04, 9 ft bgs) at a concentration of 0.0086 mg/kg, which was well below the NMED SSL and NMED DAF 1. Xylene is not a COPC associated with the operations of the Vapor Recovery Unit (SWMU 26). This xylene detection is attributed to the release from SWMU 154 (Systemic Diesel Spill). As discussed in Section 6.25.5.1 (page 38), the affected environmental media from the diesel spill (SWMU 154) extend below SWMU 26.~~

6.4.5.1.2 Deep Soil (Greater than 10 ft bgs)

Benzene and ethylbenzene were detected in deep soil above the DAF 20 criteria near SWMU 26. These detections in deep soil are attributable to the Systemic Diesel Spill (SWMU 154) and are not indicative of a release from this unit; therefore, these constituents are not addressed further for SWMU 26.

6.4.5.2 *SVOCs*

~~6.4.5.1.2~~6.4.5.2.1 Shallow Soil (0 to 10 ft bgs)

No SVOCs were detected in shallow soils (• 10 ft bgs) at this unit.

6.4.5.2.2 Deep Soil (Greater than 10 ft bgs)

Naphthalene was the only SVOC detected above the DAF 20 in deep soil near SWMU 26. Naphthalene is not a COPC associated with operations at the Vapor Recovery Unit (SWMU 26) and is not indicative of a release from this unit. This constituent is

related to the Systemic Diesel Spill (SWMU 154) and is, therefore, not addressed here for SWMU 26.

6.4.5.3 *Other Parameters*

~~6.4.5.1.3~~6.4.5.3.1 Shallow Soil (0 to 10 ft bgs)

Concentrations of TPH were detected in five of the six shallow soil samples analyzed for TPH. TPH are not COPCs associated with the operations of the Vapor Recovery Unit (SWMU 26). Samples tested for TPH were also tested for full suites of VOCs and SVOCs that would comprise the TPH. No SVOCs were detected and no~~. Only one~~ VOCs ~~(xylene)~~ w~~as~~ere detected at concentrations exceeding regulatory criteria~~ in one sample and the constituent is not associated with SWMU 26~~. These conditions confirm that TPH is not a risk to potential receptors.

6.4.5.3.2 Deep Soil (Greater than 10 ft bgs)

Concentrations of TPH were detected in deep soils in the vicinity of SWMU 26. TPH are not COPCs associated with the operations of the Vapor Recovery Unit and are not indicative of a release from this unit. The TPH in deep soils ~~is~~are attributable to the Systemic Diesel Spill (SWMU 154) and, therefore, are not addressed further for SWMU 26.

~~6.4.5.2~~6.4.5.4 *Metals*

6.4.5.4.1 Shallow Soil (0 to 10 ft bgs)

With the exception of arsenic, which is attributable to redox conditions at the HELSTF, no metals were detected in shallow soils near SWMU 26 at concentrations above the SSL or DAF 20 values.~~Arsenic, barium, chromium, and lead were all detected in shallow soil sample collected in the vicinity of SWMU 26. The arsenic and barium detections do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained arsenic or barium. As described previously, arsenic and barium detections are attributable to naturally occurring conditions existing at the HELSTF. None of the other metals were detected above their respective NMED SSLs or DAF 1 screening values.~~

6.4.5.4.2 Deep Soil (Greater than 10 ft bgs)

The only metals that occurred in deep soil near SWMU 26 at concentrations above the DAF 20 were the naturally-occurring constituents arsenic and selenium. Arsenic detections are which are attributable to redox-related conditions at the HELSTF. Selenium was identified during the review of professional literature as a naturally occurring solid waste mineral in the Tularosa Basin. Chromium was detected in all 16 samples analyzed for it at concentrations ranging from 1 to 13 mg/kg. There is no DAF 20 value for chromium. However, there were no chromium exceedances in shallow soils and, therefore, these chromium occurrences in deep soil are likely not associated with a release to the surface from above ground SWMU 26.

6.4.5.2.16.4.5.4.3 Shallow Soil Summary

6.4.5.3 *No COPCs associated with SWMU 26 were detected in soil in the vicinity of the unit. No constituents were detected above the SSL in shallow soil in the vicinity of SWMU 26. A few petroleum hydrocarbon constituents associated with the Systemic Diesel Spill Site – were detected above the DAF 20 in deep soils. These occurrences are not indicative of a release from SWMU 26.In summary, naphthalene was the only constituent detected in deep soil at concentrations exceeding the DAF 20. The presence of naphthalene at depth is likely related to the release from SWMU 154.SystemicSystemicSystemicDeep Soil (Greater than 10 ft bgs)*

At the fFour soil boring locations were evaluated in the vicinity of SWMU 26 where samples deeper than 10 ft bgs were collected (142B1, CFW-04, HCF-01, and HLSF-SB-019). The results for deep soil are included in Table 6.4-1. , 12 VOCs, 11 SVOCs, 9 metals, TPH, organic carbon, nitrite/nitrate, and phosphorus were detected above laboratory reporting limits. Table 6.4-3 provides a statistical summary of data for deep soil and Table 6.4-4 provides a summary of exceedances of regulatory standards for deep soil at SWMU 26.

6.4.5.3.1 VOCs

Benzene and ethy benzene were detected in deep soil near SWMU 26.

The following 12 VOCs were detected in deep soils in the vicinity of SWMU 26: 1,1-DCA, acetone, benzene, ethylbenzene, isopropylbenzene, m,p-xylene, naphthalene, n-butylbenzene, sec-butylbenzene, n-propylbenzene, o-xylene, and total xylenes. Acetone is a common laboratory artifact and its detection is likely attributable

to laboratory contamination. Additionally, it should be noted that its detection is isolated to three samples collected from one location (142B1) in the vicinity of this SWMU. Therefore, the detection of acetone is not attributable to soil conditions at this SWMU and it is not considered a COPC. With the exception of 1,1-DCA, the detected VOCs are not considered COPCs associated with this SWMU. These detections in deep soil are attributable to the SystematicDiesel Spill (SWMU 154) and are not indicative of a release from this unit; therefore, these constituents are not addressed further for SWMU 26. There was only one detection of 1,1-DCA at 142B1 (19 ft bgs) at 0.0160 mg/kg, which is below the NMED DAF 1 screening value.

6.4.5.3.2 SVOCs

The following 11 SVOCs were detected above laboratory reporting limits: 1,2,4-TMB, 1,3,5-TMB, 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, anthracene, dibenzofuran, diphenylamine, fluorene, phenanthrene, and pyrene.Naphthalene was the only SVOC detected above the DAF 20 in deep soil near SWMU 26. The trimethylbenzenes, diphenylamine, and PAHs areNaphthalene is not a COPCs associated with operations at the Vapor Recovery Unit (SWMU 26) and areis not indicative of a release from this unit. Thisese constituents are is related to the Systematic Diesel Spill (SWMU 154) and areis, therefore, not addressed here for SWMU 26.

6.4.5.3.3 Other Parameters

Concentrations of TPH were detected in deep soils in the vicinity of SWMU 26. TPH are not COPCs associated with the operations of the Vapor Recovery Unit and are not indicative of a release from this unit. The TPH in deep soils is attributable to the Systematic Diesel Spill (SWMU 154) and, therefore, are not addressed further for SWMU 26.

Nitrite/nitrate, organic carbon, and phosphorus were also detected in deep soils in the vicinity of SWMU 26. These constituents are likely attributable to naturally occurring conditions existing at the HELSTF.

6.4.5.3.4 Metals

The only metals that occurred in deep soil near SWMU 26 at concentrations above the DAF 20 were the naturally-occurring constituents arsenic and selenium. Chromium was detected in all 16 samples analyzed for it at concentrations ranging from 1 to 13

mg/kg. There is no DAF 20 value for chromium. However, there were no chromium exceedances in shallow soils and, therefore, these chromium occurrences in deep soil are likely not associated with a release to the surface from above ground SWMU 26. The following nine metals were detected in deep soil above laboratory reporting limits: arsenic, barium, cadmium, chromium, hexavalent chromium, lead, selenium, sodium, and zinc. As discussed previously, arsenic, barium, selenium, and sodium are attributable to naturally occurring conditions at the HELSTF. None of the chromium, hexavalent chromium, or lead detections exceeded their respective NMED DAF 1 screening values. Cadmium was detected in 4 of the 18 deep soil samples designated for this analysis. Only one cadmium detection exceeded the NMED DAF 1 (1.37 mg/kg); a concentration of 2.00 mg/kg was detected at HCF-01 at a depth of 19 to 20 ft bgs. This exceedance has been delineated vertically and laterally in this area. There is evidence to suggest that cadmium is a COPC associated with operations of the Vapor Recovery Unit, and its absence in shallow soils in this area confirms that it did not originate from the Vapor Recovery Unit.

6.4.5.3.5 Deep Soil Summary

In summary, naphthalene was the only constituent detected in deep soil at concentrations exceeding the DAF 20. The presence of naphthalene at depth is likely related to the release from SWMU 154. cadmium was detected above a regulatory standard in deep soils in the vicinity of SWMU 26. This was an isolated occurrence, and it occurred in deep soil approximately 40 feet southeast of the exterior portion of SWMU 26. Cadmium is not a COPC associated with this SWMU, and the isolated exceedance is not attributed to a release from the Vapor Recovery Unit.

6.4.6 Human Health Risk Assessment Findings

An HHRA was not conducted for SWMU 26 because there have not been any site-specific investigations conducted at this SWMU. The data used to evaluate conditions for this SWMU were collected as part of assessments conducted to investigate SWMUs 142 and 154. The results of the HHRAs conducted at SWMUs 142 and 154 are provided under Sections 6.12.6 (page 210) and 6.21.6 (page 342), respectively.

6.4.7 Ecological Risk Assessment Findings

An ERA was not conducted for SWMU 26 because there have not been any site-specific investigations conducted at this SWMU. The data used to evaluate conditions for these SWMUs were collected as part of assessments conducted to investigate

SWMUs 142 and 154. The results of the ERAs conducted at SWMUs 142 and 154 are provided under Sections 6.12.7 (page 213) and 6.21.7 (page 344), respectively.

6.4.8 Conclusions and Recommendations

There have been no documented releases from SWMU 26. Spent scrubbing liquids were formerly sent to the former Chemical Waste Tanks (SWMUs 31 and 32). These tanks were removed from service in 1989. Between 1989 and April 2009, spent scrubbing solutions were collected in drums inside the Cleaning Facility and stored under permit at another location. This unit was taken out of service in April 2009 when the Cleaning Facility operations ceased.

There were no detected COPCs in ~~shallow~~ soils in the vicinity of SWMU 26, which is indicative that a ~~significant~~ release to the surface has not occurred in this area.~~With the exception of 1,1-DCA, the VOCs detected in soil in the vicinity of SWMU 26 are those typically associated with the releases from SWMU 142 (Cleaning Facility Sump) and are being addressed by the RFI and corrective action at that SWMU. The SVOCs detected in soils in this area are also attributable to SWMU 154.~~

~~Cadmium was detected in one deep soil sample collected from 19 to 20 feet at concentrations that exceeded NMED DAF 1 screening values; cadmium was not detected in the deeper sample from this boring. Cadmium was not detected in any of the shallow soil samples evaluated for this SWMU. Cadmium is not a COPC related to the operations conducted at SWMU 26. The isolated exceedance of cadmium in the deep soil sample is not attributed to SWMU 26. The source of this detection is being attributed to SWMU 142 (Cleaning Facility Sump).~~ Based on knowledge of historical operations and management practices for liquid wastes generated from the unit, along with results of soil analyses for sampling locations in the vicinity of the unit, SWMU 26 is eligible for NFA and should be removed from the RCRA process.

6.5 SWMU~~s~~ 27 ~~through 30~~ – Sanitary Treatment ~~System~~ Impoundment (CCWS-79; WSMR-44)

6.5.1 Unit Description

Four large sanitary treatment impoundments (formerly SWMUs 27, 28, 29 and ~~through~~ 30) are located on the east side of the HELSTF. SWMUs 27 through 30 were combined as SWMU 27 under the December 2009 WSMR RCRA permit. These impoundments replaced the~~wo~~ previous unlined impoundment~~s~~ (now designated

SWMU 148, Former Multi-function Array Radar [MAR] Waste Stabilization Pond) in the early 1980s. Each of the impoundments consists of a polyethylene-lined cell surrounded by earthen berms and the four impoundments collectively cover an area of approximately two acres. The two westernmost impoundments (formerly designated SWMUs 27 and 28) are interconnected by a narrow inlet and have a total operating volume of 1.3 million gallons. The two easternmost impoundments (formerly designated as SWMUs 29 and 30) are also interconnected by a narrow inlet and have a total operating volume of 2.3 million gallons. SWMUs 27 through 30 formerly received sanitary wastewater and surface run-off from the HELSTF. As part of the system operation, biological degradation was maintained by aeration and extended residence. Evaporation was accelerated by spraying and sludge was occasionally removed and disposed of in a landfill (A.T. Kearney, 1988).

Although the 1988 RFA (A.T. Kearney, 1988) and subsequent RFI reports have stated that two unlined sewage lagoons with earthen berms built in 1962 were demolished and replaced by the current lagoons in the same location, the 2006 Phase III RFI Work Plan (WTS, 2006) states that a review of MAR and HELSTF history and an aerial photograph review revealed that there were no unlined lagoons previously located where these lagoons are located. The Former MAR Waste Stabilization Pond (SWMU 148) was located 200 feet northwest of SWMU 27, and according to the 2006 Phase III RFI Work Plan, was most likely what the RFA described as the previous sewage lagoons. SWMU 27, 28, 29, and 30 was taken out of service in at the end of 2007 when newly constructed lagoons were placed into service in a different location.

6.5.2 Operational History

The Former MAR Waste Stabilization Pond (SWMU 148) was replaced in 1981 by a polyethylene-lined, two-cell, Total Evaporation Lagoon (SWMUs 27 and 28).

On July 22, 1983, the USACE petitioned the State of New Mexico for approval to operate a domestic water system (Discharge Plan [DP] 297) under a permanent groundwater discharge permit at the facility, which included the two existing cells (SWMUs 27 and 28) and proposed construction of two additional lagoons (SWMUs 29 and 30), that would be polyethylene-lined and have a capacity of 2 million gallons. In a letter dated August 23, 1983, to the USACE, WSMR indicated that the permanent lagoon system would consist of a lined four-cell total evaporation system having a maximum operating volume of approximately 3.6 million gallons. The liner specifications consisted of a reinforced Hypalon® sheet made by encapsulating reinforced fabric between two sheets of 15-mil or heavier gauge Hypalon® sheeting.

DP-297 was approved on October 31, 1983. SWMUs 29 and 30 became operational in 1984 (WTS 2006).

As part of DP-297, wastewater was aerated by subsurface injection aeration pumps and sequentially treated in each of the four lagoons (A.T. Kearney, 1988). Liquid was spray-aerated in the last lagoon (SWMU 30). The treatment system began receiving excess water in late 1984 and was nearly overloaded. The increased domestic water load was alleviated on September 12, 1984, when New Mexico approved the use of domestic wastewater for soil compaction during construction activities. On October 25, 1984, the State also granted permission to discharge 15,000 gallons per day to the HELSTF STP Dry Pond (SWMU 146) for 120 days. The source of the excess water was identified as cooling tower water, PRS pump cooling water, and PRS boiler water. The facility submitted a Discharge Plan (DP-386) on March 28, 1985, to discharge 41,300 gallons per day to the HELSTF STP Dry Pond (SWMU 146). On November 5, 1985, the State granted permission to discharge only the cooling tower water and pump cooling water (but not the PRS boiler water) without a permit. The State terminated the unapproved DP-386 in 1989 (WTS, 2006).

A release of chromated water that occurred at Test Cell 1 on June 12, 1986 (Teasdale, 1986) ~~that~~ was eventually pumped from trenches outside the deionized water room into the sewage lagoons. The chromium concentration in the lagoons was measured at 1.6 ppm. Another release of chromate water occurred at Test Cell 1 on January 13, 1987 (Teasdale, 1987), to a dry well where it was neutralized with sodium sulfite and pumped to the Chemical Waste Tanks (SWMUs 31 and 32). It is not known if the chromated water entered the Sewage Treatment System; however, adjacent drainage and fluid trenches were later modified (Hayslett, 1988).

A large quantity of potable water flowed directly into the sewage lagoons on February 27, 1987, due to a broken float valve in a cooling tower (Davies, 1987). As a result, an undetermined amount of wastewater overflowed out of the sewage lagoons. The State granted permission for the facility to discharge PRS scrubber water to the Sanitary Treatment System on July 3, 1989. DP-297 expired and was not renewed because WSMR claimed that Sovereign Immunity applies to the operation of the Sanitary Treatment System.

~~Waste associated with the operation of SWMUs 27 through 30 includes sanitary wastes and surface water runoff. As previously described, a chromium release was pumped to the sewage lagoons in 1986. In addition, cooling tower water, pump cooling water, and PRS water were discharged to these SWMUs in the mid-1980s.~~

The sanitary sewage lagoons are believed to have been one of the historical sources of vadose zone water present in the HELSTF area. In 2009, prior to conducting supplemental sampling at SWMU 27, the lagoons were inspected visually and sludge thickness measurements were taken. Each of the four lagoons contained 12 to 18 inches of sludge. The sludge in former SWMUs 27, 28, and 29 was dry, but the sludge in SWMU 30 was wet. There was no standing water in any of the lagoons. Although the liners were in place in all four lagoons, grass, bushes, and small trees were observed growing through the liners on the berms and in the pond areas. The berms were intact around all of the ponds. The potential contaminants associated with SWMU~~s~~ 27 ~~through 30~~ include those constituents associated with sewage and those associated from occasional discharges to the system, including cooling water with hexavalent chromium, solvents, detergents, and PRS scrubber water.

6.5.3 Regulatory History

~~The original Discharge Plan, DP-297, was approved on October 31, 1983, and renewed on July 31, 1987. Permission was granted on July 3, 1989, to discharge the PRS scrubber water to the Sanitary Treatment System. DP-297 expired and was not renewed because WSMR has claimed that Sovereign Immunity applies to the operation of the sanitary water treatment system.~~The ~~HSWA~~ 1989 operating permit listed the Sanitary Treatment System at the HELSTF ~~(SWMUs 27 through 30)~~ as requiring further action, and . ~~T~~the December 2009 permit lists SWMU 27 as a SWMU that requires corrective action (NMED, 2009). Phase I (1992) and II (1994) RFIs conducted at SWMU 27 determined there was no evidence of a release and, therefore, petitions for no further action (NFA) were submitted to the NMED in January 2000 and September 2001 (MEVATEC, 2000 and 2001). The NMED denied the request for NFA in both petitions in 2002, indicating that a final RFI report and ecological risk assessment (ERA) were required for SWMU 27 (NMED, 2002). As a result, a Phase III RFI was conducted in 2006. Based on the sampling results, the RFI concluded that there was no evidence of a release from SWMU 27. In August 2008, the NMED issued a Notice of Disapproval Letter to WSMR for the HELSTF Phase III RFI Report (NMED, 2008a). For SWMU 27, the NMED indicated that the collection of surface and subsurface soil, taken from borings drilled beneath the lined lagoons, would be required.~~As indicated in the Phase III RFI Work Plan, the reason for prioritizing these units for investigation could not be determined. Assessment of these units was proposed as part of an RFI for Appendix I sites.~~

~~During finalization of the 1999 Annual Unit Audit, these SWMUs were moved to Table A.2 of the Annual Unit Audit, indicating that NFA is appropriate because the~~

~~lagoons are active. However, a petition for NFA was denied by NMED on March 11, 2002, because a final RFI report and ERA were required (WTS, 2006)~~Four monitoring wells (HMW-01 through HMW-04) located in the immediate vicinity of SWMUs 27 through 30 are routinely sampled as part of the WSMR groundwater monitoring program. Influent samples were collected at the Sewage Lagoons on a quarterly basis while they were in operation.

6.5.4 Investigative History

~~A summary of monitoring points used to investigate SWMUs 27 through 30 is provided in Table 4 of Appendix D-2.~~ The monitoring points used to evaluate SWMU 27 are shown on Figure 6.5-1. Locations of wells that are not in the immediate vicinity of the unit are shown on Figure 4.3-~~9~~10. ~~-~~Phase I, II, and III RFIs, as well as two supplemental sampling events have been conducted at SWMU 27. The soil data are summarized in Table 6-5, and the sludge data are summarized in Table 6-6. Descriptions of these assessments are provided below.

Phase I RFI

The Phase I RFI was designed to assess vadose zone water contamination. As part of the Phase I RFI, four vadose zone monitoring wells (HMW-01 through HMW-04) were installed in April 1991. ~~Sediment~~Sludge samples and surface water samples were also collected from each of the four lagoons. Samples were analyzed for VOCs, SVOCs, RCRA metals, and total cyanide.

~~Sediment~~Sludge data collected as part of the Phase I RFI indicate that several inorganics were detected at concentrations below Toxicity Characteristics [TC]) determined by Toxicity Characteristic Leaching Procedure (TCLP) analysis and below soil background levels detected in a background soil boring. ~~Barium was detected in sediment from all four lagoons, and lead was detected in three of the four lagoons (SWMUs 27, 28, and 30). Other inorganics were detected in sediment as follows: mercury in SWMU 27; cadmium and cyanide in SWMU 28; and chromium in SWMU 30.~~ The VOC, 1,1-DCA, was detected at trace concentrations in the ~~sediment~~ sludge sample collected from SWMU 30. The only constituent detected in surface water from all of the lagoons was barium, at trace concentrations.

Vadose zone water data collected from the four monitoring wells indicated detections of 1,1,1-TCA (HMW-04), arsenic (HMW-02), and barium (HMW-03) at concentrations below drinking water standards and New Mexico Water Quality standards in effect in

1992. Vadose zone water data indicated detections of selenium above drinking water standards at all four monitoring well locations. Concentrations of cadmium were detected above drinking water standards in vadose zone water collected from Monitoring Well HMW-03.

The Phase I report stated that the detections in the vadose zone water from monitoring wells at these SWMUs ~~27 through 30~~ did not correlate with the ~~sediment~~sludge and surface water results, indicating that the lagoons were not the source of the detected constituents in the vadose zone water. The Phase I RFI report concluded that ~~the concentrations of~~ selenium, cadmium, and 1,1,1-TCA were detected at wells upgradient from the sewage lagoons. In addition, the report stated that selenium in the vadose zone water could be naturally occurring. The detections were not attributed to releases associated the lagoons. In response to these conditions, additional groundwater monitoring at the four monitoring wells was recommended.

Phase II RFI

As part of the Phase II RFI, groundwater data were collected from seven nearby vadose zone monitoring wells (HMW-01 through HMW-04, HMW-12, HMW-14, and HMW-16) for VOCs, RCRA metals (total and dissolved), and TDS analysis. The groundwater sample collected from HMW-02 was also analyzed for hexavalent chromium, TPH, and SVOCs due to its proximity to SWMU 143 (HELSTF Storage Yard Chromium Spill Site).

No hexavalent chromium, TPH, or SVOCs were detected in vadose zone water from HMW-02. TDS concentrations in vadose zone water from all seven wells exceeded NMED's aquifer protection standard of 10,000 mg/L. Water from HMW-16 had an elevated pH value ~~(12.09)~~, above the Secondary Maximum Contaminant Level and New Mexico Water Quality Standard.

Vadose zone water data collected from Monitoring Well HMW-12 indicated concentrations of ~~the VOCs~~ 1,1-DCE above the MCL and New Mexico Groundwater Standard in 1994 ~~(80.3J µg/L)~~ and 1,1,1-TCA ~~(116J µg/L)~~ above the 1994 MCL ~~regulatory limits~~. The VOC 1,1-DCE was also detected at concentrations above ~~regulatory limits~~the 1994 New Mexico Groundwater Standard in the vadose zone water samples from Monitoring Wells HMW-04 ~~(5.70J µg/L)~~ and HMW-16 ~~(6.70J µg/L)~~.

Cadmium (detected in groundwater during the Phase I RFI) was not ~~No concentrations of cadmium were~~ detected in any of the groundwater samples collected during the

Phase II RFI. Chromium was detected above ~~regulatory limits~~the 1994 MCL in vadose zone water from Monitoring Wells HMW-12 (~~60 µg/L~~ dissolved) and HMW-16 (~~980 µg/L,~~ total). ~~; dissolved chromium was also detected in vadose zone water from HMW-04, below the regulatory standard (34 µg/L).~~ Total lead was detected at concentrations above ~~regulatory limits~~the 1994 MCL in groundwater collected from Monitoring Well HMW-01 ~~(18 µg/L)~~. Selenium was detected above the 1994 MCL in all seven wells. ~~, with the highest dissolved concentration from HMW-01 (529 µg/L) and the lowest dissolved concentration from HMW-16 (26 µg/L).~~

The Phase II RFI concluded that the contamination in vadose zone water was not correlated to lagoon ~~sediment~~sludge and surface water data from SWMU~~s~~ 27 ~~through 30~~ and, therefore, the lagoons ~~a~~were not the source of impacts to vadose zone water. The report stated that the sources of lead, chromium, 1,1-DCE, and 1,1,1-TCA were unknown. The Phase II RFI stated that the lagoons should be removed from the RFI process, but indicated that ~~nearby~~ surrounding wells could be used to monitor ~~inged for~~ nearby SWMUs. NMED did not agree with those conclusions~~,~~ and requested~~ing~~ further evaluation of the water balance, a final RFI report, and an ERA as part of a Phase III RFI (Kelly, 1996). The U.S. Environmental Protection Agency (USEPA) also disagreed with the Phase II RFI and required further delineation of contamination in groundwater (Honker, 1995).

Phase III RFI (WTS, 2008a, ARCADIS 2009)

The Phase III RFI Work Plan (WTS, 2006) stated that the liners of the SWMUs had been compromised, based on observations of tears in the liners and trees growing through them. As part of the Phase III RFI, a water balance was ~~to be performed on~~planned for the lagoons to determine the potential loss of wastewater due to unlined processes (percolation or overflow). ~~The h~~Historical data for the sewage pond influent were also to be added to the HELSTF database~~. The data were to be~~ and evaluated against existing and future data to further characterize the impact from the lagoons. It was determined that ~~T~~the water balance was ~~not completed for the sewage lagoons. According to the Phase III RFI Report (WTS, 2008), the water balance was~~ unnecessary because SWMU~~s~~ 27 ~~through 30~~ was~~ere~~ being ~~taken off-line in 2007~~removed from serice and the vadose zone water was expected to dissipate once ~~they were not in~~ operation ceased. The lagoons were removed from operation during late 2007~~2008~~ and replaced by new lagoons at a different location in the HELSTF.

During implementation of the Phase III RFI, a~~A~~ downgradient monitoring well (HMW-58) was installed and sampled in the Regional Aquifer downgradient from SWMU~~s~~ 27

~~through 30~~. Additional groundwater samples were collected from six existing vadose zone monitoring wells (HMW-01 through HMW-04, HMW-12, and HMW-14) and one existing regional well (DRW-14). ~~Existing Regional Well HMW-16 was also proposed for sampling, but was not sampled during the Phase III RFI.~~ Groundwater samples were ~~was~~ analyzed for water quality parameters, ammonia nitrogen, dissolved ions, phosphorus, hexavalent chromium, cadmium, copper, lead, sodium, zinc, alcohols, VOCs, and TOC. No soil borings were advanced as part of the Phase III RFI at SWMU~~s~~ 27 ~~through 30~~.

There were no detections above regulatory standards for metals ~~(cadmium, chromium, copper, lead, and silver)~~ in vadose zone water collected from HMW-01 through HMW-04 in 2006. However, 1,1-DCE was detected in vadose zone water from HMW-04 above the ~~regulatory standard~~NMED Groundwater Standard in 2006. ~~1,1-DCA and chloroform were also detected in water from HMW-04, but below regulatory standards.~~ Vadose zone water from HMW-12 had a chromium concentration above the ~~regulatory standard~~ New Mexico Groundwater Standard. In 2006, vadose zone water from HMW-14 had detected concentrations of TCE and 1,1-DCE below their respective standards. Chloride, fluoride, and sulfate exceeded their respective ~~regulatory standards~~ New Mexico Groundwater Standards in vadose zone water from these six wells in 2006. As discussed in Section 4.3 (page 24), these three constituents ~~chloride and sulfate~~ are naturally~~–~~occurring and are not attributable to a release from this unit.~~Fluoride, which is naturally occurring, is not considered a COPC for SWMUs 27 through 30 because it is not a constituent of any wastes managed in these units.~~

With the exception of chloride and sulfate, which are naturally occurring, there were no exceedances of regulatory standards for the constituents analyzed in groundwater from the newly installed Regional Well HMW-58. ~~Regional Well DRW-14 is located north (i.e., cross-gradient) of SWMUs 27 through 30. In 2006, g~~Groundwater from DRW-14, located north (i.e., cross-gradient) of SWMU 27 had detections of chromium, 1,1-DCE, TCE, chloride, fluoride, and sulfate above their respective ~~regulatory standards~~NMED Groundwater Standards.

2008 Sampling Event

Following the removal of the sewage lagoons (SWMU 27) from service, a sampling event was conducted in March 2008 to characterize the residual sludge remaining in the lagoons. Five sludge samples were collected from each of the four lagoons and were initially analyzed for total chromium, hexavalent chromium and TCLP VOCs,

SVOCs, Pesticides and RCRA 8 metals (Figure 6.5-1). The TCLP analytical results indicated that, if removed and disposed, the sludge would be characterized as a non-hazardous waste.

Based on the initial laboratory results, WSMR decided to further evaluate the SWMUs for potential closure in place without sludge removal. Half of the original sludge samples were analyzed for the following total metals: antimony, arsenic, barium, beryllium, cadmium, cobalt, copper, lead, mercury, nickel, selenium, silver, tin, thallium, vanadium, and zinc. Although the sludge represents waste material and is not environmental media subject to comparison to the NMED's clean-up standards, the NMED standards are provided in Table 6-6~~.5-2~~ for information purposes. Table 6-6~~.55~~ includes the results for the total metals analyses (including the chromium and hexavalent chromium results) and indicates that several inorganic constituents were detected in sludge; however, none of the detections exceeded the NMED Soil Screening Levels (SSLs). The laboratory reports for the 2008 sampling event are provided in Appendix D-1. The results of the 2008 sampling event were presented in a letter report from WTS to WSMR dated May 2008 (WTS, 2008a).

2009 Supplemental Sampling Event

In August 2008, NMED issued a Notice of Disapproval Letter (Bearzi, 2008a) to WSMR for the HELSTF Phase III RFI Report (WTS, 2006). For SWMU 27, the NMED indicated that the collection of surface and subsurface soil, taken from borings drilled beneath the lined lagoons, would be required. In response to the Notice of Disapproval letter, a supplemental RFI sampling event was conducted in December 2009 to obtain sludge and subsurface soil samples from the four sewage lagoons. Samples of sludge material and the native soil beneath the liners were collected from five locations within each lagoon (see Figure 6.~~-~~5-1). The analytical reports for this sampling event are provided in Appendix D-1.

Five samples of sludge were collected by hand auger from each of the four sewage lagoons (above the liner). The samples were analyzed for VOCs, SVOCs, RCRA 8 metals, and hexavalent chromium. Results of the laboratory analysis indicated that several organic and inorganic constituents were detected in the sludge (see Table 6-6~~.5-2~~). With the exception of one mercury concentration and two estimated concentrations of arsenic that were detected above the DAF 10, none of the constituents analyzed exceeded regulatory limits in sludge.

Five native soil samples were collected from beneath the liner of each lagoon at or near the same locations that the sludge samples were collected (see Figure 6-~~5.5-1~~). A hand auger was used to collect samples from the upper two feet of underlying soil. The twenty (20) soil samples were analyzed for VOCs, SVOCs, RCRA 8 metals, and hexavalent chromium. The analytical results for soil are provided in Table 6-~~5.5-1~~. With the exception of one estimated concentration of arsenic that was detected above the DAF10, none of the constituents analyzed exceeded regulatory limits in soil. Arsenic is naturally occurring in soil at the HELSTF.

6.5.5 Nature and Extent of Contamination

As discussed above, the sewage lagoon sludge was sampled in 2008 and 2009 and and shallow soils (beneath the liner) were sampled in 2009. The sludge material was characterized for disposal purposes in 2008 and was determined to be non-hazardous. The lagoon sludge would not normally be compared to soil screening levels; however, as a conservative approach, laboratory results from both the soil and sludge from the four lagoons were compared to NMED residential SSLs and the DAF 10. Soil for borings drilled for the installation of DRW-09 and DRW-10 were evaluated for potential impacts to deep soils in the vicinity of SWMU 27.

~~No soil samples have been collected in the immediate vicinity of SWMUs 27 through 30. Sediment and surface water samples collected from the lagoons in 1991 indicated the presence of 1,1-DCA, barium, lead, mercury, cadmium, chromium, and cyanide in sediment and barium in surface water. Results of VOC and SVOC analyses for deep soil samples (deeper than 30 ft bgs) from nearby borings for Wells DRW-09 and DRW-10 were evaluated for indications of potential releases from SWMUs 27 through 30. However, these data are not considered adequate to fully characterize soil conditions in the vicinity of SWMUs 27 through 30. Because soil data for DRW-09 and DRW-10 are deeper than 10 ft bgs, any detections of COPCs in this deeper subsurface interval do not represent a risk to human health and ecological receptors. The locations of DRW-09 and DRW-10 are shown on Figure 6.5-1, and a comprehensive data summary for soil is provided in Table 4 of Appendix D-2.~~A total of forty (40) sludge samples were collected from the four (4) sewage lagoons in 2008 and 2009. Twenty soil samples were collected below the liner (0 – 2 feet below ground surface [ft bgs]) within the four sewage lagoons.

Two nearby soil sample locations were used to evaluate potential impacts to deep soils around SWMU~~s~~ 27 ~~through 30~~. At DRW-10, approximately 75 feet northwest of the eastern SWMU boundary, soil samples were collected at three different depth intervals:

36 to 38, 38 to 40, and 54 to 56 ft bgs. At DRW-09, approximately 70 feet northwest of the northwest corner of the SWMU, soil samples were collected from three different depth intervals: 32 to 34, 34 to 36, and 58 to 60 ft bgs. These deep soil samples were analyzed only for VOCs and selected SVOCs. Table 6-5 provides a summary of analytical results for ~~sludge,~~shallow and deep soil samples collected at SWMU 27.

~~6.5.5.1 *Sludge*~~

~~A total of forty (40) sludge samples were collected from the four (4) sewage lagoons in 2008 and 2009. Table 6.5-2 provides a summary of the analytical results.~~

6.5.5.1 *VOCs*

6.5.5.1.1 Sludge

No VOCs were detected in sludge above the NMED SSLs or DAF10 standards.

6.5.5.1.2 Shallow Soil (0 to 10 ft bgs)

No VOCs were detected in shallow soil above the NMED residential SSLs or the DAF10.~~No VOCs were detected in sludge above the NMED SSLs or DAF10 standards.~~

6.5.5.1.3 Deep Soil (Greater than 10 ft bgs)

There were no detections of VOCs in deep soil (>10 ft bgs) at either DRW-09 or DRW-10.

6.5.5.2 *SVOCs*

6.5.5.2.1 Sludge

No SVOCs were detected in sludge above the NMED SSLs or DAF10 standards.

6.5.5.2.2 Shallow Soil (0 to 10 ft bgs)

No SVOCs were detected in shallow soils at SWMU 27.

6.5.5.2.3 Deep Soil (Greater than 10 ft bgs)

There were no detections of SVOCs in deep soil (>10 ft bgs) at either DRW-09 or DRW-10.

6.5.5.3 *Metals*

6.5.5.3.1 Sludge

No metals were detected in sludge above the NMED SSLs for residential soil. Estimated concentrations of arsenic were reported above the DAF10 standard in two sludge samples (LAGN2-SL-03 and LAGN4-SL-03). An estimated concentration of arsenic was also reported in one of the duplicate samples from collected at LAGN3-SL-05, but the result was not replicated in the ~~duplicate~~ parent sample. It should be noted that arsenic was not detected in the native soil collected below these locations. In addition, influent samples collected in 2001 did not contain dissolved arsenic. Mercury was detected above the DAF10 in sludge from LAGN-1-SL-05. An estimated concentration of mercury was detected below the residential SSL and DAF 10 in the underlying soil at this location. No other constituents were detected in sludge above the ~~NMED residential SSLs or the~~ DAF10 standards. ~~Estimated concentrations of arsenic were reported above the DAF10 standard in two sludge samples (LAGN2-SL-03 and LAGN4-SL-03). An estimated concentration of arsenic was also reported in one of the duplicate samples from collected at LAGN3-SL-05, but the result was not replicated in the duplicate sample. It should be noted that arsenic was not detected in the native soil collected below these locations. In addition, influent samples collected in 2001 did not contain dissolved arsenic. Mercury was detected above the DAF10 in sludge from LAGN-1-SL-05. An estimated concentration of mercury was detected below the residential SSL and DAF 10 in the underlying soil at this location. No other constituents were detected in sludge above the NMED residential SSLs or the DAF10 standards.~~

6.5.5.3.2 Shallow Soil (0 to 10 ft bgs)

Arsenic (naturally occurring) was detected (estimated value) above the DAF10 in a single sample (LAGN3-SB-02 - 0.3 to 0.9 ft bgs) collected from shallow soil at former SWMU 29. No other metals concentrations were detected above the NMED residential SSLs or DAF 10 at SWMU 27.

6.5.5.3.3 Deep Soil (Greater than 10 ft bgs)

No samples collected from deep soils (>10 ft bgs) were analyzed for metals. ~~*Shallow Soil (0 to 10 ft bgs)*~~

~~Twenty soil samples were collected below the liner (0 – 2 feet below ground surface [ft bgs]) within the four sewage lagoons. Table 6.5-1 provides a summary of analytical results and COPC detections at SWMU 27.~~

~~VOCs~~

~~No VOCs were detected in shallow soil above the NMED residential SSLs or the DAF10.~~

~~SVOCs~~

~~No SVOCs were detected in shallow soils at SWMU 27.~~

~~Metals~~

~~Arsenic (naturally occurring) was detected (estimated value) above the DAF10 in a single sample (LAGN3-SB-02 - 0.3 to 0.9 ft bgs) collected from shallow soil at former SWMU 29. No other metals concentrations were detected above the NMED residential SSLs or DAF 10 at SWMU 27.~~

~~Shallow Soil Summary~~

~~In summary, no COPCs were detected in the shallow soils above regulatory standards at SWMU 27. Thus, there is no evidence of a release to the surface from these lagoons.~~

~~6.5.5.2 *Shallow Soil (0 to 10 ft bgs)*~~

~~No samples were collected from shallow soils (• 10 ft bgs) for SWMUs 27 through 30.~~

~~6.5.5.3 *Deep Soil (Greater than 10 ft bgs)*~~

~~Two nearby soil sample locations were used to evaluate potential impacts to soils around SWMUs 27 through 30. At DRW-10, approximately 75 feet northwest of the eastern SWMU boundary, soil samples were collected at three different depth intervals:~~

~~36 to 38, 38 to 40, and 54 to 56 ft bgs. At DRW-09, approximately 70 feet northwest of the northwest corner of the SWMU, soil samples were collected from three different depth intervals: 32 to 34, 34 to 36, and 58 to 60 ft bgs. The samples were analyzed only for VOCs and selected SVOCs.~~ Analytical results for deep soils are included in Table 6.5-1 ~~provides a statistical summary of data for deep soil and Table 6.5-2 provides a summary of exceedances of regulatory standards for deep soil at SWMUs 27 through 30.~~

~~6.5.5.3.1 VOCs~~

~~There were no detections of VOCs in deep soil (>10 ft bgs) at either DRW-09 or DRW-10.~~

~~6.5.5.3.2 SVOCs~~

~~There were no detections of SVOCs in deep soil (>10 ft bgs) at either DRW-09 or DRW-10.~~

~~6.5.5.3.3 Metals~~

~~No samples collected from deep soils (>10 ft bgs) were analyzed for metals.~~

6.5.5.4 ~~*Deep*~~ *Soil Summary*

In summary, no COPCs were detected in the shallow soils above regulatory standards at SWMU 27. Thus, there is no evidence of a release to the surface from these lagoons. ~~In summary, D~~deep soils located near SWMU ~~s~~ 27 ~~through 30~~ did not exhibit any impacts associated with activities at the SWMU. Depths to vadose zone water in DRW-09 and DRW-10 ~~in 2006 were~~ are approximately 35.9 and to 39.5 ft bgs, respectively; thus, the deep soil samples collected are representative of saturated soils. There is no evidence of a release to deep soil from SWMU 27.~~Soils in the vicinity of the sewage lagoons have not been characterized. Pursuant to comments 11 and 18 in NMED's letter dated August 27, 2008, WSMR will propose collection of additional soil data for these SWMUs. The results of the sampling will be used to determine if corrective measures are warranted. Preliminary nature and extent and risk evaluations described herein were performed on the available deep soil dat~~

~~To enhance the soils evaluation, results of vadose zone water were reviewed. With the exception of elevated concentrations of chloride, fluoride, and sulfate, no other~~

~~constituents (metals, VOCs, or SVOCs) analyzed in 2006 were detected above regulatory standards in vadose zone water from DRW-09 and DRW-10. In 2007, selenium was detected above the regulatory standard in water from DRW-10.~~Groundwater samples from Regional Wells HMW-16, located at the upgradient, southwest corner of former SWMU 28, and DRW-14, located north and cross-gradient of SWMU 27, have shown~~s had~~ concentrations of chromium and hexavalent chromium above the ~~regulatory~~New Mexico Groundwater ~~s~~Standards. However, chromium and hexavalent chromium have not been detected above regulatory standards in Regional Wells HMW-63 and HMW-58, downgradient from SWMU~~s~~ 27 ~~through 30~~. ~~Based on the locations~~The detections of chromium and hexavalent chromium above regulatory standards ~~exceedances~~ in regional groundwater upgradient and cross-gradient of SWMU 27~~in the vicinity of these SWMUs,~~ most likely originate from the HELSTF Storage Area Chromium~~ate~~ Spill Site ~~Area~~ (SWMU 143) or another source located off site to the north-northwest of thi~~s~~e HELSTF.~~area appears to be the source of the chromium in regional groundwater downgradient of the Sewage Lagoons.~~

Selenium, chloride, fluoride, and sulfate have been detected in downgradient regional wells at concentrations exceeding regulatory standards. As discussed previously, the detections of chloride, sulfate, and selenium concentrations in the vadose zone and Regional Aquifer are attributed to naturally occurring conditions.~~It should be noted that background fluoride concentrations are above standards and that localized concentrations of fluoride near this SWMU, while above standards, are within the range of variability observed over the rest of the site.~~

6.5.6 Human Health Risk Assessment Findings

6.5.7 Human Health Risk Assessment Findings

Soil data and saturated vadose zone soil water data generated from the site RFI characterization activities were used in the evaluation of risk to human health. As a conservative measure, sludge samples collected from the site in 2008 and 2009 were also included in the soil data set. A description of risk assessment methodologies and results is provided in page 73 of Appendix E.

6.5.7.1 *Soil Exposure Scenarios*

In accordance with NMED guidance (NMED, 2009a), constituent concentrations in surface soil and sludge and in combined surface and subsurface soil and sludge were compared to health-based screening levels and the calculated ratios summed. The

ratios were multiplied by $1x10^{-5}$ for carcinogens and by 1 for non-carcinogens. The results of this data screening process indicate that after comparison to health-based soil screening levels for industrial worker exposure, residential exposure, and construction worker exposure, no COPCs were identified for surface soil and sludge or for combined surface and subsurface soil and sludge at SWMU 27. This demonstrates that the constituent concentrations in surface soil and sludge and in combined surface and subsurface soil and sludge at SWMU 27 are unlikely to result in adverse health impacts to the following potential receptors via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, dermal):

- Current and future site workers;
- Future residents (adults and children); and
- Future construction workers.

6.5.7.2 *Vapor Intrusion Scenarios*

No VOC COPCs were identified in saturated vadose zone soil water. However, all the VOCs detected in total soil and sludge were selected as COPCs for the vapor intrusion evaluation. The findings of the vapor intrusion evaluation indicate that potential future industrial or residential development of the site would not result in potential indoor air exposures that above the regulatory benchmarks for cancer risks and non-cancer hazards.

This demonstrates that the constituent concentrations in soil and sludge and saturated vadose zone soil water at SWMU 27 are unlikely to result in adverse health impacts to the following potential receptors via inhalation of indoor air:

- Future site workers; and
- Future residents (adults and children).

All detected VOCs in total soil and sludge (i.e., vadose zone) were selected as COPCs for the future vapor intrusion evaluation because there are no NMED or USEPA soil screening levels screening levels that are protective of the vapor intrusion pathway. The total Excess Lifetime Cancer Risk (ELCR) values for the future vapor intrusion exposure pathway for the site worker scenario and for the residential scenario are below or within the acceptable target risk range of 10^{-6} to 10^{-4} for carcinogenic effects.

The total Hazard Index (HI) values for the future vapor intrusion exposure pathway for the site worker scenario and for the residential scenario are below the benchmark of one (1) for non-cancer hazard, indicating adverse non-carcinogenic effects are unlikely to occur.

Based on these results, additional human health risk assessment is not warranted for SWMU 27.

6.5.8 Ecological Risk Assessment Findings

A Screening Level Ecological Risk Assessment (SLERA) and Baseline Ecological Risk Assessment (BERA) were completed for SWMU 27 to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents detected in surface soil and sludge and subsurface soil, and to conduct food chain modeling for the Constituent of Potential Ecological Concern (COPECs) identified as bioaccumulative (Appendix E). The results of the SLERA and BERA for direct contact exposure and for food chain modeling indicate that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in soil and sludge. Therefore, no further ecological evaluation of SWMU 27is warranted.~~Data collected during site characterization activities during the RFIs were used in the evaluation of risk to human health. A description of risk assessment methodologies and results is provided on page 70 of Appendix E.~~

~~6.5.6.1 *Soil Exposure Scenarios*~~

~~No surface or combined surface and subsurface soil samples (0 to 10 ft bgs) were collected at SWMUs 27 through 30. Therefore, no COPCs were selected for surface or combined surface and subsurface soil at SWMUs 27 through 30.~~

~~6.5.6.2 *Vapor Intrusion Scenarios*~~

~~Saturated vadose zone water COPCs were selected by comparing the analytical data with vapor intrusion screening levels for groundwater (USEPA, 2002a). Appendix E presents the selection of the saturated vadose zone water COPCs for the HHRA. No COPCs were identified for saturated vadose zone water at SWMUs 27 through 30. This demonstrates that the constituent concentrations in total soil at SWMUs 27 through 30 are unlikely to result in adverse health impacts to the following potential receptors via inhalation of indoor air:~~

- ~~Future site workers; and~~

- ~~Future residents (adults and children).~~

~~6.5.7 Ecological Risk Assessment Findings~~

~~As described within the ERA for SWMUs 27 through 30 presented on page 71 of Appendix E, the settling ponds are no longer active and were dry and devoid of vegetation during the site visit in March 2009. Combined, SWMUs 27 through 30 cover an area of approximately 2 acres; however, no significant terrestrial habitat occurs within SWMUs 27 through 30. Sparse shrubs and opportunistic weeds occur along the berms of the ponds but are unlikely to support a diversity of wildlife.~~

~~Surface soil and combined surface and subsurface soil samples were not required to be collected at SWMUs 27 through 30 as part of the Phase I, II, or III RFI investigations. Therefore, no COPCs were identified for the site indicating that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in the soil. Therefore, no further ecological evaluation at SWMUs 27 through 30 is warranted.~~

~~6.5.8~~6.5.9 Conclusions and Recommendations

The sanitary sewage lagoons are believed to have been one of the historical sources of vadose zone water present in the HELSTF area. Discharges to SWMU~~s~~ 27 ~~through 30~~ ceased in 200~~7~~8. Results of sludge and soil analyses indicate that there have been no releases of hazardous constituents to the environment from SWMU 27. Risk evaluations indicate there are no adverse environmental impacts associated with SWMU 27as a result of historical site activities and no restrictions need to be applied to current or potential future land use at the site. Accordingly, the site is recommended for no further action and should be closed out of the RCRA process. ~~Although releases from these SWMUs likely occurred, data suggest that the water released was composed primarily of treated sanitary water and contained no hazardous constituents. Data collected from this area provide evidence of an upgradient source of chromium impacts. Preliminary risk evaluations have indicated that it is unlikely that there will be adverse impacts to human health or ecological receptors. WSMR has agreed to investigate environmental conditions at these SWMU~~

6.6 SWMUs 31 and 32 – Chemical Waste Tanks (WSMR-43)

6.6.1 Unit Description

The Chemical Waste Tanks were constructed in 1985 in the southeastern portion of the HELSTF and consisted of a west tank (SWMU 31) and an east tank (SWMU 32). The west tank, SWMU 31, was placed into use in late 1985 and was in operation until 1989; the east tank, SWMU 32, was never used. The tanks were to be used for containment and evaporation treatment of chromate, deionized wastewater from the laser cooling system, and hazardous waste generated at the HELSTF Cleaning Facility (HCF). These were identical, above-grade, open-top tanks constructed of reinforced concrete. Each had an industrial grade 45-mil Hypalon® liner with a leak detection system and each contained a 6-inch layer of ballast sand. The interior dimensions of the tanks were 37 feet by 74.7 feet by 7 feet deep, sloping to 7.5 feet deep in the center. The capacity of each tank was approximately 108,200 gallons. The design included a double-walled drain line (1,000 feet in length) to carry wastewater from the HCF sump (SWMU 142) to the chemical waste tanks. The drain line consisted of a 3-inch-diameter reinforced thermosetting resin pipe (RTRP) encased by a secondary 6-inch-diameter RTRP.

6.6.2 Operational History

Full-scale operations of the HCF began in June 1983 and consisted of a single-walled line for transferring waste from a sump in the HCF (SWMU 142) to a 2,100-gallon tank (SWMU 24) located along the building's northeastern exterior wall. After the facility began operations in 1983, it was determined that the tank volume at SWMU 24 would not be adequate to contain the volume of waste generated at the cleaning facility. Due to these conditions, the west tank (SWMU 31) and east tank (SWMU 32) were constructed in 1985 (Figure 6.6-1). Wastes from the HCF sump (SWMU 142) were transferred to SWMU 31 via a double-walled pipe. SWMU 31 also received other wastes that were transported by truck and dumped directly into the tank, including chromate wastes, Low Power Chemical Laser (LPCL) scrubbing water, Chemistry Lab wastes and potassium hydroxide wastes. SWMU 32 was never used according to facility records and reports.

Shortly after operations began in 1985, leak detection ports for both tanks began to contain a measurable amount of liquid. The concentrations of chromium in the ports were significantly lower than that measured in SWMU 31. WSMR suggested that the water in the tank ports was attributed to either concrete hydration or groundwater

intrusion (Hayslett, 1987). A double-walled drain line was tied into the existing line at the HCF between 1988 and 1989. The line was used to carry small quantities of various chemical reagents from floor and sink drains in the HELSTF Chemistry Lab (AOC Q).

Use of SWMU 31 was halted in 1989 when Freon 11 and 1,1,1-TCA were discovered in the leak detection port. SWMU 31 was emptied on October 17, 1989. A pressure test was conducted on the line connecting the HCF sump and tanks in November 1990 (Lockheed Engineering & Sciences Company [LESC], 1991c). The testing revealed that the secondary containment pipe was not intact. The internal service line (which carried product) appeared to be intact. The entire line was subsequently filled with concrete.

The tanks were decontaminated and demolished in February 1992 in accordance with procedures specified within an approved closure plan (Advanced Sciences, Inc. [ASI], 1992). During demolition of the tank, it was discovered that the Hypalon® liner had been compromised.

Waste streams associated with this SWMU included laser mirror cooling water and wastewater solutions from the HCF. Cooling water contained zinc sulfate, a silicate salt, potassium hydroxide, an organic phosphorate, a carboxylic acid, an aromatic heterocyclic mercaptan, and a chromate salt. Wastewater from the HCF contained phosphoric acid, sodium hydroxide, sodium carbonate, MEK, isopropyl alcohol, toluene, formic acid, methylene chloride, nitric acid, and hydrofluoric acid (A.T. Kearney, 1988).

The potential contaminants associated with SWMUs 31 and 32 include those constituents associated with solvents, acids, corrosion inhibitors, water treatment, and detergents.

6.6.3 Regulatory History

The HCF and related waste evaporation pond were originally included in the 1978 Construction Permit Application for air emission sources. A construction permit (No. 192) was issued to the facility on June 13, 1978. However, changes to the planned construction occurred and included building holding tanks for the storage of cleaning wastes instead of operating an evaporation pond.

The final design of the holding tanks was approved and incorporated within the facility's RCRA permit application in 1984. The tanks were also included as a RCRA unit in the permit application and subsequently became part of the October 1989 Part B Hazardous Waste Permit for WSMR. Tank operations resulted in a series of notices of violations (NOVs) between 1985 and 1988 due to suspected leaks in the secondary containment system and deficiencies in the RCRA Part B application relating to the units (Rebuck, 1985; Pache, 1986; Burkhart, 1988).

On September 11, 1989, the regulatory agency ordered WSMR to stop using the chemical waste storage tanks and to begin removing waste after a leak in the interstitial liner was discovered (Hamilton, 1989). On September 13, 1989, WSMR requested that the units be removed from the RCRA permit application. On September 26, 1989, the agency notified WSMR that their request for removal of the tank system from the application was granted so they could respond to the release under interim status. The RCRA permit issued to WSMR on October 24, 1989, did not include the tanks as a SWMU requiring investigation under the permit.

A formal closure plan for the tank system was submitted to the state regulatory agency on February 15, 1990. Following several revisions to the plan that were based upon comments from the regulatory agencies, the final closure plan for the tanks was approved on June 28, 1991. A modification to the closure plan was requested by WSMR on July 27, 1992, to complete a hydrogeologic investigation and to commence monitoring activities of the vadose zone water around the HCF. On September 21, 1992, the agency approved the modifications with the condition that WSMR prepare a comprehensive monitoring plan for the HCF.

WSMR requested that tank closure activities be conducted concurrently with RFI activities associated with the HCF and HELSTF Systemic diesel spill (SWMU 154) and the interim response measure at SWMU 154 (Morgan, 1992a).

WSMR submitted the Comprehensive Groundwater Sampling and Analyses Plan for the HCF on November 25, 1992. The final Groundwater Sampling and Analyses Plan was submitted on November 12, 1993, following extensive review and comment from the agency. The final plan did not include any monitoring activities near the chemical waste tanks.

The 1999 Annual Unit Audit (dated June 6, 2000) placed SWMUs 31 and 32 in Table A.2., indicating that NFA is required for the units (Dinwiddie, 2000). However, NMED comments included in Table A.2. indicate that closure documentation is

required in order to obtain a formal NFA for the units. SWMUs 31 and 32 are listed on the facility's December 2009 RCRA permit as SWMUs requiring corrective action (NMED, 2009).

6.6.4 Investigative History

No Phase I or II RFI activities were conducted at SWMUs 31 and 32. As indicated in the Phase III RFI Work Plan, no monitoring wells or soil borings were installed at the units. Soil data that were reportedly collected beneath the tanks during closure activities were not available for review. As previously described, samples of the fluid in the SWMU's' leak detection ports indicated detections of 1,1,1-TCA, Freon 11, and chromium. Because it was necessary to demonstrate that no releases have occurred beneath the units, assessment beneath the unit was proposed as part of the Phase III RFI. The proposed Phase III RFI action indicated that three borings would be completed at the former tank locations to determine if a release impacted subsurface soils. No groundwater monitoring was proposed.

Phase III RFI

Three soil borings (HLSF-SB-29, HLSF-SB-30, and HLSF-SB-31) were advanced to 50 ft bgs beneath the former units. Samples were collected at the surface and every 10 feet to the total depth of the boring. Soil samples were analyzed for hexavalent chromium, eight RCRA metals, total zinc, alcohols, VOCs, TPH-DRO, TPH-GRO, TOC, and general geochemical parameters. ~~Arsenic was the only constituent detected above the NMED SSL and the NMED DAF 1. The arsenic detections do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained arsenic. As described previously, arsenic detections are attributable to naturally occurring conditions existing at the HELSTF.~~

6.6.5 Nature and Extent of Contamination in Soil

~~6.6.5.1~~ *In order to delineate the extent of soil impacts at SWMUs 31 and 32, 18 soil samples from three soil borings advanced as part of the Phase III RFI activities were evaluated (Figure 6.6-1).* *A comprehensive data summary for soil is provided in Table 6-7.6* ~~*Data collected from the three borings installed at the site during the Phase III RFI fieldwork indicate detections of arsenic in 9 of 18 soil samples. However, arsenic is not a COPC associated with this SWMU. As discussed previously, the detections of arsenic are being attributed to naturally occurring conditions at the HELSTF are not being considered a waste constituent.A comprehensive data summary for soil is provided in Table 5 of Appendix D-2. Shallow Soil (0 to 10 ft bgs)*~~

~~Of the three samples collected from shallow soil (• 10 ft bgs), no analytes were detected above their respective NMED SSLs~~ or DAF 20 values. ~~for residential soil. Barium, chromium, lead, and zinc were detected in shallow soils but were well below the NMED SSL and NMED DAF 1. Table 6.6-1 provides a statistical summary of data for shallow soil and Table 6.6-2 provides a summary of exceedances of regulatory standards for shallow soil at SWMUs 31 and 32.~~

6.6.5.1 *VOCs*

6.6.5.1.1 Shallow Soil (0 to 10 ft bgs)

No VOCs were detected in shallow soils (• 10 ft bgs) at these units.

6.6.5.1.2 Deep Soil (Greater than 10 ft bgs)

No VOCs were detected in deep soils (>10 ft bgs) at these units.

6.6.5.2 *SVOCs*

~~6.6.5.1.2~~6.6.5.2.1 Shallow Soil (0 to 10 ft bgs)

No SVOCs were detected in shallow soils (• 10 ft bgs) at these units.

6.6.5.2.2 Deep Soil (Greater than 10 ft bgs)

No SVOCs were detected in deep soils (>10 ft bgs) at these units.

6.6.5.3 *Metals*

~~6.6.5.1.3~~6.6.5.3.1 Shallow Soil (0 to 10 ft bgs)

No metals were detected in shallow soils above NMED SSLs for residential soil or the DAF ~~1~~20 criteria.

6.6.5.3.2 Deep Soil (Greater than 10 ft bgs)

No metal COPCs were detected above the DAF 20 in deep soil at these units.~~Barium, chromium, lead, and zinc were detected at less than 10 ft bgs in SB-029, SB-030 and SB-031, but concentrations were well below the NMED SSL and DAF 1 values.~~

6.6.5.4 *Other*

6.6.5.4.1 Shallow Soil (0 to 10 ft bgs)

No TPH were detected in shallow soils. The only alcohol detected was n-butanol; none of the detections exceeded the NMED residential SSL.

6.6.5.4.2 Deep Soil (Greater than 10 ft bgs)

No TPH were detected in deep soils at these units.

~~6.6.5.2~~6.6.5.5 ~~*Shallow*~~ *Soil Summary*

~~6.6.5.3~~ *In summary, the upper 10 feet of soil at this SWMU are not impacted based on soil sampling performed at this SWMU. None of the identified COPCs (solvent constituents, detergent-related constituents, alcohols, or chromium) for SWMUs 31 and 32 were detected in deep soils at this unit. Thus, there is no evidence of a release from this unit.~~~~Deep Soil (Greater than 10 ft bgs)~~

~~A summary of the results for deep soil at SWMUs 31 and 32 is included in Table 6.6-1. Table 6.6-3 provides a statistical summary of data for deep soil and Table 6.6-4 provides a summary of exceedances of regulatory standards for deep soil at SWMUs 31 and 32.~~

~~6.6.5.3.1 VOCs~~

~~No VOCs were detected in deep soils (>10 ft bgs) at these units.~~

~~6.6.5.3.2 SVOCs~~

~~No SVOCs were detected in deep soils (>10 ft bgs) at these units.~~

~~6.6.5.3.3 Metals~~

~~No metal COPCs were detected above the DAF 20 in deep soil at these units.~~

~~Other~~

~~No TPH were detected in deep soils at these units.~~

~~Barium, chromium, lead, and zinc were detected at depths greater than 10 feet in all three borings. However, all detections were below their respective NMED DAF 1 standards. As shown on Figure 6.6-2, detections of cadmium exceeding the NMED DAF 1 screening value (1.37 mg/kg) were observed at SB-030 (49 to 50 ft bgs) and SB-031 (10 to 11, 20 to 21, and 49 to 50 ft bgs). Cadmium concentrations ranged from 1.06 mg/kg to 2.38 mg/kg in these borings.~~

~~There were no detections of cadmium above drinking water criteria at Vadose Zone Wells HMW-03 located adjacent to SWMUs 31 and 32. There were no detections of cadmium in Regional Aquifer Well MW-58. There has been no data collected at Regional Well HMW-16 situated adjacent to SWMUs 31 and 32 since 1992. Based upon these conditions, cadmium detected in deep soil at SWMUs 31 and 32 has been delineated and has not affected the groundwater. A discussion of groundwater conditions is provided in Section 6.25 (page 38) and a summary of the groundwater analytical data is provided in Tables 1 and 2 of Appendix D-3.~~

~~6.6.5.3.4 Deep Soil Summary~~

~~In summary, none of the identified COPCs (solvent constituents, detergent-related constituents, alcohols, or chromium) for SWMUs 31 and 32 were detected in deep soils at this unit. Thus, there is no evidence of a release from this unit.~~

6.6.6 Human Health Risk Assessment Findings

Data collected during site characterization activities during the RFIs were used in the evaluation of risk to human health. A description of risk assessment methodologies and results is provided on page 88 of Appendix E.

The results of this data screening process indicate that after comparison to health-based soil screening levels for industrial worker exposure, residential exposure, and construction worker exposure, no COPCs were selected for surface soil or for combined surface and subsurface soil at SWMUs 31 and 32. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMUs 31 and 32 are unlikely to result in adverse health impacts to the identified current and potential future receptors. Additionally, no VOCs were detected in soil, indicating that vapor intrusion is unlikely to result in adverse health impacts. Based on these results, additional HHRA is not warranted for SWMUs 31 and 32.

6.6.7 Ecological Risk Assessment Findings

As described within the ERA presented on page 89 of Appendix E, a screening-level risk assessment was completed for SWMUs 31 and 32. Based on the analysis of available information, there is adequate information to conclude that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in the soil. Therefore, no further ecological evaluation at SWMUs 31 and 32 is warranted.

6.6.8 Conclusions and Recommendations

No COPCs ~~were detected in the upper 10 feet of soil at SWMUs 31 and 32. In addition, none of the COPCs~~ associated with ~~these units~~SMWUs 31 and 32 were detected in soils at concentrations exceeding the applicable regulatory standards.~~during the Phase III RFI. Cadmium was detected in three deep soil samples at concentrations that exceeded NMED DAF 1 screening values. Cadmium was not detected in any of the shallow soil samples evaluated for this SWMU. Cadmium was not detected in samples collected from nearby Vadose Zone Well HMW-03 or Regional Aquifer Well MW-58. Based upon these conditions, cadmium detected in deep soil at SWMUs 31 and 32 was delineated, but is not a COPC associated with this SWMU.~~

An HHRA was conducted to evaluate exposure to COPCs in surface soil, combined surface and subsurface soil, and total soil for site workers under current and future land-use conditions and construction workers and residents (adult and child) under

hypothetical future land-use conditions. The results of the HHRA indicate that no additional human health risk assessment is warranted. A SLERA was completed for SWMUs 31 and 32 to evaluate surface soil and subsurface soil for ecological receptors. The results of the SLERA indicate there is adequate information to conclude that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in the soil. Therefore, no further ecological evaluation at SWMUs 31 and 32 is warranted.

Based on the results of the RFI and the findings of the HHRA and ERA, the SWMUs are recommended for NFA and closeout of the RCRA process.

6.7 SWMUs 33 and 34 – Fluorspar Tanks (WSMR-49)

6.7.1 Unit Description

The Fluorspar Tanks are located in the southeastern portion of the HELSTF area. The tanks consist of two 30-foot by 60-foot concrete tanks that extend 2 to 4 ft bgs with no secondary containment. The tanks serve as drying beds for fluorspar sludge that is generated by an emission control scrubber at the Laser System PRS (AOC-V) (A.T. Kearney, 1988).

6.7.2 Operational History

The Fluorspar Tanks were constructed in 1984 and received their last deposit of fluorspar sludge in the spring of 2009. The PRS treated combustion products from the laser operations in order to remove the hydrogen fluoride (HF) and deuterium fluoride (DF) and resulting exhaust gases were vented to the atmosphere. The emission control scrubber on the system used a solution of sodium hydroxide to react with the HF and DF to form sodium fluoride. The solution was then treated with lime to form fluorspar (calcium fluoride). The sludge was pumped to the drying bed through a 4-inch PVC pipe. Each tank has a sloped entrance from the south for use by a front-end loader for removal of the dry solids. The waste dried sludge was periodically collected and transported off site for disposal. The waste sludge was assumed to have a very high pH during the 1988 RFA (A.T. Kearney). These tanks were historically used once per week, but were later used only once every 3 months up until 2009 (Reynolds, pers. comm., 2009a). WSMR discontinued the use of the Laser System PRS and the SWMUs 33 and 34 tanks in the spring of 2009 (Reynolds, pers. comm., 2009a).

The potential contaminants associated with SWMUs 33 and 34 ~~include those constituents associated with~~ are calcium fluoride and sodium hydroxide.

6.7.3 Regulatory History

As part the 1988 RFA, it was reported that evidence of tank overfilling was observed. Dried sludge was noted on the ground surface surrounding the tanks during a visual assessment (A.T. Kearney, 1988). Due to these conditions, the Fluorspar Tanks (SWMUs 33 and 34) were listed in Appendix II of the RCRA Permit as requiring further investigation.

As further described in the following section ~~under Section 6.7.4 (Investigative History, page 38)~~, assessment of site conditions was conducted at SWMUs 33 and 34 as part of the Phase I RFI. Based upon data collected during the RFI, it was reported that no evidence of releases were identified (ITC, 1992c). On October 12, 1993, WSMR requested a Class III permit modification to place these units on a list requiring NFA in response to these conditions.

During January 1995, the USEPA issued a Statement of Basis/Final Decision and Response to Comments Summary that approved the NFA petition (Harris, 1995). The SWMUs were placed in Table A.2 of the Annual Unit Audit on June 6, 2000, indicating that NFA is required. However, the table indicated the tanks ~~did~~ required a RCRA Operating Permit (Dinwiddie, 2000). According to information obtained during a recent interview with WSMR personnel, the fluorspar is neutralized before it is discharged to the Fluorspar Tanks. WSMR has determined that these tanks are exempt from RCRA permitting because they are used only for elementary neutralization purposes (Reynolds, pers. comm., 2009b). These SWMUs are listed in the current December 2009 RCRA permit as units requiring corrective action (NMED, 2009).

6.7.4 Investigative History

~~A summary of monitoring points used to investigate SWMUs 33 and 34 is provided in Table 6 of Appendix D-2.~~ Soil sampling and groundwater monitoring well locations are shown on Figure 6.7-1, and~~.~~ ~~a summary of analytical results is provided in Table 6-8.7-1.~~ Descriptions of assessments are provided below.

Phase I RFI

As part of the Phase I RFI, four soil borings (33/34B1 through 33/34B4) were placed at the corners of the tanks with samples collected at 0, 1, and 2 ft bgs. One background boring (33/34BG) was also advanced with samples collected at 1 and 2 ft bgs. The RFI also included the installation and sampling of a vadose zone monitoring well (HMW-19) west of the tanks.

Soil samples were analyzed for pH and fluoride. ~~The maximum fluoride detection from the four borings surrounding the tanks was 0.98 mg/kg (33/34B1 surface). The background boring had a maximum fluoride detection of 1.1 mg/kg (33/34BGS002).~~ No ~~analytes~~fluoride concentrations detected in ~~from the~~ soil ~~samples~~ were ~~detected~~ above the fluoride SSL for residential soil. ~~(3,670 mg/kg) or NMED DAF 1 screening level (329 mg/kg)~~. All soil samples had pH levels reported to be indicative of pH in soils from the Tularosa Basin (7.5 to 8.0 standard units).

Groundwater samples collected from HMW-19 during the Phase I RFI in 1992 were analyzed for field pH, VOCs, SVOCs, TPH, metals, and fluoride. Fluoride was detected at 2.3 mg/L, which exceeded the 1992 New Mexico groundwater quality criterion (1.6 mg/L).

Based upon these results, it was concluded that no releases from SWMUs 33 and 34 were evident and that the RFI be discontinued for SWMUs 33 and 34.

Phase II RFI

No Phase II RFI activities were conducted at SWMUs 33 and 34.

Phase III RFI

There were no Phase III RFI field activities specific to SWMUs 33 and 34 except for collection of groundwater samples from nearby Vadose Zone Monitoring Wells HMW-19 and HMW-24.

HMW-19 was dry during the Phase III RFI sampling event in December 2006. Groundwater samples collected from HMW-24 were analyzed for water quality parameters, dissolved ions, sodium, and TOC. Laboratory results showed detected concentrations of the naturally occurring constituents selenium, chloride, fluoride, and

sulfate that exceeded the NMED groundwater standards ~~and concentrations of barium below NMED groundwater standards~~.

6.7.5 Nature and Extent of Contamination in Soil

In order to investigate the extent of soil impacts at SWMUs 33 and 34, 12 soil samples from four soil borings advanced as part of the Phase I RFI activities were evaluated. All soil samples were collected from the upper 2 feet and ~~The soil samples~~ were analyzed for pH and fluoride. ~~Of the four samples collected from shallow soil (• 10 ft bgs), no analytes~~None of the fluoride detections exceeded the ~~were detected above the fluoride~~ SSL for residential soil, and pH values were 7.5 to 8.1. ~~(3,670 mg/kg) or NMED DAF 1 screening level (329 mg/kg). The maximum detection of fluoride was in the background sample 33/34BG (2 ft bgs) at 1.10 mg/kg.~~ Table 6-8.7-1 summarizes the results found at these sample locations.

Fluoride was detected in vadose zone water above the NMED groundwater standard in monitoring wells HMW-19 (in 1992) and HMW-24 (in 2006). HMW-19 has been dry during subsequent sampling events. As discussed in Section 6.25.8 (page 383), fluoride is ubiquitous across the site and is generally detected in both vadose zone and regional groundwater samples at concentrations above the New Mexico standards. Based on extensive research discussed in Section 4.3.6 (page 44), fluoride in the HELSTF groundwater is consistent with naturally occurring ~~background~~ conditions identified in the literature review. Spatial analysis of fluoride detections in both the vadose zone water and regional groundwater indicated no pattern of spatial distribution suggestive of impacts correlated to site activities.

~~In summary, all soil samples were collected from 2 ft bgs or shallower and were analyzed for fluoride and pH, the only potential constituents of concern associated with SWMUs 33 and 34.~~

~~As part of the Phase I RFI activities, HMW-19 was installed, sampled, and analyzed for pH, VOCs, SVOCs, TPH, metals, and fluoride. Only fluoride was detected in the water sample (2.3 mg/L), which is above the NMED groundwater standard.The Phase III RFI activities included the sampling of nearby Vadose Zone Monitor Wells HMW-19 and HMW-24. HMW-19 was found to be dry and concentrations of selenium, chloride, fluoride, and sulfate exceeding NMED groundwater standards were detected at HMW-24. As discussed in Section 4.3.6 (page 38), the detections of chloride, sulfate, and selenium concentrations in the vadose zone and Regional Aquifer are attributed to naturally occurring conditions.As discussed in Section 6.25.8 (page 38), fluoride is~~

~~ubiquitous across the site and is generally detected in both vadose zone and regional groundwater samples at concentrations above the NM standards. Based on extensive research discussed in Section 4.3.6 (page 38), fluoride in the HELSTF groundwater is consistent with naturally occurring background conditions. Spatial analysis of fluoride detections in both the vadose zone water and regional groundwater indicated no pattern of spatial distribution suggestive of impacts correlated to site activities.~~ In summary, fluoride was not detected in soil above the NMED SSL ~~or DAF 1~~ at SWMUs 33 and 34. The occurrence of fluoride in groundwater is not indicative of a release from these SWMUs. Fluoride exceedances of the New Mexico groundwater standard in vadose zone water from HMW-24 are further discussed under Section 6.25.8 (page 383). A summary of groundwater analytical results is provided in Tables 1 and 2 of Appendix D-2~~3~~.

6.7.6 Human Health Risk Assessment Findings

The data used for the HHRA of SWMUs 33 and 34 consist of the same data sets used for the Revised Phase III RFI Report. The ~~primary~~ source of the soil data was the Phase I RFI (ITC, 1992a; b). Risk assessment data sets for soil for SWMUs 33 and 34 were compiled, summarized, and statistically analyzed using methods described in the HELSTF Risk Assessment (page 97 of Appendix E).

The results of this data screening process indicate that after comparison to health-based SSLs for industrial worker exposure, residential exposure, and construction worker exposure, no COPCs were selected for surface soil or for combined surface and subsurface soil at SWMUs 33 and 34. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMUs 33 and 34 are unlikely to result in adverse health impacts to the identified current and potential future receptors. Based on these results, additional HHRA is not warranted for SWMUs 33 and 34.

6.7.7 Ecological Risk Assessment Findings

As described in the ERA presented on page 98 of Appendix E, a screening-level risk assessment was completed for SWMUs 33 and 34. There are no completed exposure pathways for ecological receptors under current conditions and no COPECs were identified for potential future exposures to soil. Based on the analysis of available information, there is adequate information to conclude that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in the soil. Therefore, no further ecological evaluation at SWMUs 33 and 34 is warranted.

6.7.8 Conclusions and Recommendations

The concentrations of fluoride in shallow soils where it was reported in the 1988 RFA that historical releases had occurred did not exceed the NMED SSL for residential soil ~~or the DAF 1 value~~. The soil pH values were within the normal range of pH values for the native soil. As discussed in Section 6.25.8 (page 383), the occurrence of fluoride in groundwater is not indicative of a release from these SWMUs.

The HHRA concluded that constituent concentrations in surface soil and in combined surface and subsurface soil at SWMUs 33 and 34 are unlikely to result in adverse health impacts to the identified current and potential future receptors and that no further human health risk assessment is warranted. In addition, the SLERA indicated that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in the soil. Therefore, no further ecological evaluation at SWMUs 33 and 34 is warranted

~~An HHRA was conducted to evaluate exposure to COPCs in surface soil, combined surface and subsurface soil, and total soil for site workers under current and future land-use conditions and construction workers and residents (adult and child) under hypothetical future land-use conditions. The HHRA concluded that constituent concentrations in surface soil and in combined surface and subsurface soil at SWMUs 33 and 34 are unlikely to result in adverse health impacts to the identified current and potential future receptorsA SLERA was completed for both SWMUs to evaluate surface soil and subsurface soil for ecological receptors. The results of the SLERA indicate there is adequate information to conclude that there are no significant current exposures to soil, and future adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in the soil. Therefore, no further ecological evaluation at SWMUs 33 and 34 is warranted.~~

There are no environmental impacts associated with SWMUs 33 and 34 as a result of historical site activities and no restrictions need to be applied to current or potential future land use at the site. Accordingly, the site is recommended for NFA and closeout of the RCRA process.

6.8 SWMUs 35 and 36 – Ethylene Glycol Tanks at HELSTF (WSMR-50)

6.8.1 Unit Description

The two former Ethylene Glycol Tanks were located in the southeastern portion of the HELSTF. The portable 500-gallon steel aboveground tanks were first placed in operation in early 1988 and were still in use at the time of the 1988 RFA. Each tank was approximately 5 feet long by 4 feet wide by 4 feet tall and had less than 500 gallons capacity. At the time of the 1988 RFA, one tank was located west of the Chemical Waste Tanks (SWMUs 31 and 32) and the second tank was located south of one of the sanitary wastewater treatment lagoons (SWMU 30). The tanks were filled when the compressor system at the HELSTF developed a problem and ethylene glycol had to be removed on a one-time emergency basis (A.T. Kearney, 1988).

6.8.2 Operational History

The Ethylene Glycol Tanks were in use between early 1988 and 1989. The tanks were used to store ethylene glycol drained from the HELSTF compressor system on a one-time emergency basis. Following reuse or disposal of the ethylene glycol, the tanks were decommissioned and removed from the site through the Holloman Air Force Base Defense Reutilization and Marketing Office (DRMO). The potential contaminant associated with SWMUs 35 and 36 is ethylene glycol.

6.8.3 Regulatory History

As indicated in the 1988 RFA Report, there was no history of release associated with the two tanks. The RFA Report indicated that the tanks posed a low release potential to soil, groundwater, surface water, air, and subsurface gas because the ethylene glycol was stored in steel tanks that were well maintained and because use of the tanks was a one-time occurrence. NFA was recommended for these tanks (A.T. Kearney, 1988). The SWMUs were subsequently omitted from the RCRA Permit on October 24, 1989. The SWMUs have remained in Table A.2 of the Annual Unit Audit with NFA indicated on this record. However, they are listed on the current WSMR RCRA permit as SWMUs requiring corrective action (NMED, 2009).

6.8.4 Investigative History

No investigations were required for the assessment of SWMUs 35 and 36. No additional assessment for these SWMUs was recommended as part of the RFI process.

6.8.5 Nature and Extent of Contamination

Specific soil sampling for SWMUs 35 and 36 has not been performed because there is no history of release due to site operations. Although there is no record of release, if ethylene glycol had been released to the environment, it would rapidly biodegrade in water or soil within several days to a few weeks. Three soil borings near SWMUs 35 and 36 (HLSF-SB-029, 33/34B1, 33/34B2) were used to evaluate the soil quality conditions in the vicinity of SWMUs 35 and 36. These borings were advanced to the northwest of the reported location of one of the tanks and to the southeast of the other tank's reported location. These borings were advanced for the purpose of delineating affected soils at nearby SWMUs 31 and 32 (Former Chemical Waste Tanks) and 33 and 34 (Fluorspar Tanks). HLSF-SB-029 is the only nearby soil boring where samples deeper than 10 ft bgs were collected. The soil boring locations are shown on Figure 6.8-1~~, and~~ a comprehensive data summary for soil in the vicinity of SWMUs 35 and 36 is provided in Table 6-9~~8.7 of Appendix D-2. Table 6.8-1 provides a statistical summary of data for shallow soil and Table 6.8-2 provides a summary of exceedances of regulatory standards for shallow soil at SWMUs 35 and 36.~~

6.8.5.1 *VOCs ~~Shallow Soil (0 to 10 ft bgs)~~*

No VOCs, including ethylene glycol, were detected above the NMED SSLs for residential soil or above the DAF 20 criteria in the upper 10 feet of soil or above the DAF 20 criteria in deep soil in the vicinity of SWMUs 35 and 36.~~None of the constituents analyzed exceeded NMED SSLs or DAF 1 for residential soils in shallow soil in the vicinity of SWMUs 35 and 36.~~

~~V~~

6.8.5.1.1 Shallow Soil(0 to 10 ft bgs)

No VOCs~~, including ethylene glycol,~~ were detected above the SSLs for residential soils or the DAF ~~1~~20 criteria ~~for residential soils~~ in shallow soils in the vicinity of SWMUs 35 and 36.

6.8.5.1.2 Deep Soil (Greater than 10 ft bgs)

No VOCs were detected above the NMED DAF 20 criteria in deep soil in the vicinity of SWMUs 35 and 36.

6.8.5.2 *SVOCs*

No SVOCs were detected above the NMED SSLs for residential soil or above the DAF 20 criteria in the upper 10 feet of soil or above the DAF 20 criteria in deep soil in the vicinity of SWMUs 35 and 36.

~~6.8.5.1.2~~6.8.5.2.1 Shallow Soil (0 to 10 ft bgs)~~VOCs~~

No SVOCs were detected above the SSLs or DAF20~~1~~ for residential soil in shallow soils in the vicinity of SWMUs 35 and 36.

6.8.5.2.2 Deep Soil (Greater than 10 ft bgs)

No SVOCs were detected above the DAF 20 criteria in deep soil in the vicinity of SWMUs 35 and 36.

6.8.5.3 *Other Parameters*

No ethylene glycol was detected in shallow or deep soil in the vicinity of SWMUs 35 and 36.

6.8.5.4 *Metals*

~~6.8.5.1.3 Metals~~

~~Barium, chromium, and zinc were detected in shallow soil (less than 10 ft bgs) in HLSF-SB-029, but concentrations were well below the~~ No metals were detected above ~~the~~ NMED SSLs for residential soil and~~or~~ ~~the~~above the ~~DAF 1~~20 ~~standard~~ criteria in shallow soil and no metals were detected above the DAF 20 in deep soil in the vicinity of SWMUs 35 and 36~~.~~

~~6.8.5.1.4~~6.8.5.4.1 Shallow Soil (0 to 10 ft bgs) ~~Summary~~

No metals were detected above the NMED SSLs for residential soil or above the DAF 20 in shallow soil in the vicinity of SWMUs 35 and 36.

~~Based on the soil data collected from nearby soil borings, shallow soils (• 10 ft bgs) in the vicinity of SWMUs 35 and 36 have not been affected by past operations.~~

~~6.8.5.1.5~~6.8.5.4.2 Deep Soil (Greater than 10 ft bgs)

No metals were detected above the NMED DAF 20 in deep soil in the vicinity of SWMUs 35 and 36.

~~At the HLSF-SB-029 soil boring location where samples deeper than 10 ft bgs were collected, only arsenic was detected above the NMED DAF 1 in one sample. Arsenic is not a COPC for the Ethylene Glycol Tanks. Table 6.8-3 provides a statistical summary of data for deep soil and Table 6.8-4 provides a summary of exceedances of regulatory standards for deep soil at SWMUs 35 and 36.~~

~~6.8.5.1.6 VOCs~~

~~No VOCs, including ethylene glycol, were detected above the NMED DAF 1 for in deep soil in the vicinity of SWMUs 35 and 36.~~

~~6.8.5.1.7 SVOCs~~

~~No SVOCs were detected above the NMED DAF 1 in deep soil in the vicinity of SWMUs 35 and 36.~~

~~6.8.5.1.8 Metals~~

~~The sole arsenic detection from 49 to 50 ft bgs at HLSF-SB-029 is not attributed to conditions associated with SWMUs 35 and 36. Arsenic is not a COPC related to the former operations at the Ethylene Glycol Tanks. In addition, as described previously, arsenic detections are attributable to naturally occurring conditions existing at the HELSTF.~~

6.8.5.5 *Soil Summary*

~~6.8.5.1.9 Deep Soil Summary~~

Based on the soil data collected from soil borings in the vicinity of SWMUs 35 and 36, soils were not affected by past operations at the former ethylene glycol tanks.~~In summaryno VOCs, including ethylene glycol, were detected above the SSLs or DAF 1 criteria. No SVOCs were detected above the SSLs for residential soils or DAF 1 criteria in deep soil. Arsenic was detected in one deep soil sample. However, the detection is attributed to naturally occurring conditions beneath the HELSTF.~~

6.8.6 Human Health Risk Assessment Findings

An HHRA was not conducted for SWMUs 35 and 36 because there have not been any site-specific investigations conducted at these SWMUs. The data used to evaluate conditions for these SWMUs were collected as part of assessments conducted to investigate SWMUs 31 and 32 and SWMUs 33 and 34. The results of the HHRAs conducted at SWMUs 31 and 32 and SWMUs 33 and 34 are provided under Sections 6.6.6 (page 151) and 6.7.6 (page 156), respectively.

6.8.7 Ecological Risk Assessment Findings

An ERA was not conducted for SWMUs 35 and 36 because there have not been any site-specific investigations conducted at this SWMU. The data used to evaluate conditions for these SWMUs were collected as part of assessments conducted to investigate SWMUs 31 and 32 and SWMUs 33 and 34. The results of the ERAs conducted at SWMUs 31 and 32 and SWMUs 33 and 34 are provided under Sections 6.6.7 (page 151) and 6.7.7 (page 156), respectively.

6.8.8 Conclusions and Recommendations

No further action is recommended for these SWMUs based on the fact that the tanks were used one time to hold a non-waste product in an emergency situation, they were in service for less than 1 year, there is no history of a contaminant release from the tanks, and the tanks were removed from the site 20 years ago. In addition, ethylene glycol was not detected in soils, vadose zone water, or regional groundwater in the vicinity of the SWMUs and the data support the conclusion that there has been no release from these SWMUs.

6.9 SWMU 37 – Waste Oil Accumulation Area at Building 26121 at HELSTF

6.9.1 Unit Description

The Waste Oil Accumulation Area ~~was~~ is located in Building 26121. According to the 1988 RFA report, ~~W~~waste oil ~~was~~is collected from HELSTF vehicles and equipment and placed in 55-gallon drums prior to being transported to the Waste Oil Tank (SWMU 8). The drums were stored on a concrete pad that was covered by a roof (A.T. Kearney, 1988).

6.9.2 Operational History

Building 26121 was built in 1963. Waste oil has been collected in the Waste Oil Accumulation Area inside Building 26121 since 1982 (A.T. Kearney, 1988). Information obtained during a recent interview with WSMR personnel indicated that Building 26121 is still in use as the Heavy Equipment Maintenance Building and that all waste oil generated during maintenance activities is stored inside the building within a secondary containment structure. There was no reported storage of waste oil outside of the building (Reynolds, pers. comm., 2009a).

6.9.3 Regulatory History

As indicated in the 1988 RFA Report, there was no history of release associated with SWMU 37. The RFA Report recommended NFA for the unit (A.T. Kearney, 1988). The SWMU was subsequently omitted from the RCRA Permit dated October 24, 1989. The SWMU has remained in Table A.2 of the Annual Unit Audit with NFA indicated. However, SWMU 37 is listed in December 2009 WSMR RCRA permit as a SWMU requiring corrective action.

The potential contaminants associated with SWMU 37 include those constituents associated with waste oil.

6.9.4 Investigative History

There have been no investigations required for the assessment of SWMU 37. No additional assessment for this SWMU was recommended as part of the RFI process.

6.9.5 Nature and Extent of Contamination

The nearest soil sampling location to SWMU 37 is HMW-17 at SWMU 149, approximately 150 feet away from SWMU 37 (Figure 6.9-1). Therefore, no evaluation of nature and extent of contamination is warranted.

6.9.6 Human Health Risk Assessment Findings

An HHRA was not conducted for SWMU 37 because there have not been any site-specific investigations conducted at this SWMU.

6.9.7 Ecological Risk Assessment Findings

An ERA was not conducted for SWMU 37 because there have not been any site-specific investigations conducted at this SWMU.

6.9.8 Conclusions and Recommendations

There are no reported releases from this unit. Waste oil is accumulated in drums inside of the building within a containment structure. There is no visual evidence that any of the drums have leaked or that any release has occurred. There are no floor drains to septic systems or wastewater treatment lagoons in the Waste Oil Accumulation Area. The potential of release to the environment is minimal. Therefore, this unit is eligible for inclusion in an NFA petition.

6.10 SWMUs 38 and 39 – ~~Construction~~ HELSTF Landfills (CCWS-75; WSMR-52)

6.10.1 Unit Description

The ~~Construction~~HELSTF Landfills are located northeast of the LSTC building in a flat grassland area. The 1988 RFA conducted by A.T. Kearney did not provide enough information to determine the specific locations of the landfills. However, during the visual site inspection performed during the 1988 RFA, there were two unlined trenches in use for the disposal of construction debris. Both trenches were approximately 300 feet long by 50 feet wide by reportedly 8 feet deep. One trench was oriented approximately southwest to northeast and the other trench was oriented approximately east to west. Construction debris was clearly visible in the trenches. The landfills were surrounded by a fence with a locked gate. The actual locations of the landfills were

later determined during a Ground-Water Quality Survey conducted by the USAEHA during 1990 and confirmed by a geophysical survey in 1992.

The exact widths and depths of the units are not known. However, as further described under Section 6.10.4 (Investigative History, page 166), information obtained during the 1992 geophysical survey indicates that there were three separate abandoned landfill cells in the vicinity of SWMU 38 and two landfill cells in the SWMU 39 area. ~~(Figure 6.10-1).~~

6.10.2 Operational History

Based upon a review of historical aerial photography, it is believed that the landfills were used as early as the 1960s until 1990. The landfills received construction debris from work performed in the HELSTF area, including wood, piping material, paper, and insulation. The 1988 RFA Report prepared by A.T. Kearney indicates that excavated soil from the June 12, 1986, release of chromated water at Test Cell 1 was deposited in the construction landfill. A release report from August 23, 1988, indicates that a spill of LPCL oil into the soil near the LPCL Pump House was excavated and deposited in the landfill (Gallegos, 1988). It was estimated that the excavated soil contained 50 gallons of this nonhazardous substance. No drainage management controls have been utilized at the landfills. Construction debris and refuse were observed to be uncovered during the 1988 visual site inspection. A.T. Kearney also reported that there were no reported waste management procedures to segregate wastes or monitoring waste disposal during the initial operations of the unlined landfills.

6.10.3 Regulatory History

The 1988 RFA Report indicated that there was no history of releases discovered at SWMUs 38 and 39. The 1989 RCRA Permit listed the HELSTF Landfills as ~~Construction Landfills as~~ SWMUs 38 and 39 (Construction Landfills) in Appendix III (Lowest Priority Sites Requiring Further Investigation).

Although the Phase I and Phase II RFI reports indicated that there were no documented releases from SWMUs 38 and 39, the USEPA and NMED issued NOD letters in 1995 and 1996, respectively, requiring further action. The USEPA requested that WSMR identify and abate the source of contamination in the vadose zone. NMED requested that WSMR upgrade the cap that was in place and augment the groundwater monitoring to determine the source of contamination, to investigate possible communication between the vadose zone and Regional Aquifer, and to verify

the existence of heptachlor in the regional groundwater. The SWMUs are listed in Table A.2 of the 1999 Annual Unit Audit, indicating that corrective action was not ~~being~~ required. In correspondence from NMED dated June 6, 2000, NMED stated that SWMUs 38 and 39 had been re-designated as 38A, 38B, 38C, 39A, and 39B because the cells shown on figures in the RFI reports are not continuous. Additionally, NMED required that the units undergo closure and post-closure care under the provisions of 20 NMAC 4.1.600 based on the fact that the units operated after the effective date of RCRA (Dinwiddie, 2000). SWMUs 38 and 39 are listed as hazardous waste management units requiring closure on the current WSMR RCRA permit (NMED, 2009).

6.10.4 Investigative History

~~A summary of monitoring points~~ Sampling locations used to investigate SWMUs 38 and 39 ~~is provided in Table 8 in Appendix D-2~~are shown on Figure 6.10-1 and a comprehensive summary of analytical data for soil is provided in Table 6-10~~9~~. Descriptions of environmental assessments at SWMUs 38 and 39 are provided below.

Phase I RFI

The Phase I RFI was conducted in 1992. As part of the Phase I RFI the following activities were performed: a geophysical survey was performed to delineate the trenches, a limited soil vapor survey (SVS) was conducted to detect releases and waste sources (samples collected 5 to 7 ft bgs), six surface sediment samples were collected from drainage paths, and a background soil sample was collected. The soil and sediment samples were analyzed for VOCs, SVOCs, PCBs/pesticides, and metals.

Of the six sediment samples and the background soil sample collected, only barium and lead were detected in a sediment sample west of SWMU 39 (39SSD3B); however, the duplicate of that sample did not have detectable levels of either metal. Results of the surface sediment samples did not indicate a release to the shallow soil.

No methane was detected by the SVS, although two large areas of elevated carbon dioxide were defined, one at each of the two SWMUs (SWMUs 38 and 39) and corresponding to trenches within them.

The results of the geophysical survey indicated that three separate landfill cells operated in the area of SWMU 38 and two landfill cells in the area of SWMU 39. The

estimated sizes of the landfill cells within the SWMU 38 geophysical grid were 125 feet by 40 feet, 350 feet by 110 feet, and 260 feet by 100 feet. Only the easternmost landfill cell within SWMU 39 was fully delineated and measured approximately 220 feet by 60 feet. The Phase I RFI concluded that the subsurface conditions surrounding the landfill had not been fully delineated and that releases to the subsurface were not confirmed or defined. The Phase I RFI also concluded that surface runoff is not a migration pathway of concern.

Based upon the results of Phase I RFI activities, it was concluded that additional investigation of subsurface conditions as part of a Phase II RFI was warranted. Proposed activities included: 1) an additional geophysical survey and a second SVS to complete the delineation west of SWMU 39 and to fully delineate the vapor-phase carbon dioxide; 2) completion of eight soil borings within the boundaries of the trenches to vertically define the trenches and characterize the waste to determine future groundwater monitoring parameters; and 3) installation of five monitoring wells to approximately 100 ft bgs (in the Regional Aquifer).

Phase II RFI

The Phase II RFI included conducting a geophysical survey using Ground Penetrating Radar (GPR) and implementing a more extensive soil gas survey. Soil and groundwater sampling activities were also conducted. The results of the GPR geophysical survey determined the approximate boundaries of the undefined cells. The depths of the five delineated landfill cells could not be determined. However, based on the GPR survey, it was estimated that the westernmost cell within SWMU 39 was 120 feet by 210 feet.

Results from the Phase II soil gas survey did not indicate vapor-phase constituents in or around the identified landfill cells. The Phase II soil gas survey results did not identify any vapor-phase VOCs that indicated a significant subsurface release.

During the Phase II RFI activities, 52 soil samples were collected from one background hand-auger boring, seven newly installed monitoring wells (HMW-29 through HMW-35), and eight soil borings (SB-01 through SB-08). The ~~hand-auger~~background boring was only analyzed for RCRA metals, but the other 51 soil samples were analyzed for VOCs, SVOCs, TPH, PCBs/pesticides, and metals.

The only two VOCs detected in the soil samples were chloroform and acetone. Acetone was detected at low concentrations in five soil samples and chloroform was

detected in one sample just slightly above the quantitation limit. Acetone and chloroform concentrations were well below the 1994 regulatory action levels. TPH were detected in four samples, with the maximum detection occurring at SB-04 (4 ft bgs) at 999 mg/kg. All eight RCRA metals were detected in the 51 investigation samples and the2 ~~soil~~background soil sample~~s~~; however, none of the detections in the investigation samples were greater than the background concentrations ~~(based on the Phase II RFI background boring)~~ and none of ~~nor did~~ the detections approached 1994 regulatory standards. PCBs/pesticides were not detected in any of the soil samples.

A total of seven groundwater samples were collected during Phase II RFI activities; they were analyzed for VOCs, SVOCs, TPH, PCBs/pesticides, metals (total and dissolved), and TDS. Groundwater results from the Vadose Zone Monitoring Wells HMW-31 and HMW-33 indicated detections of chromium, arsenic, selenium, 1,1-dichloroethene (1,1-DCE), and TCE concentrations above 1994 regulatory limits. No SVOCs were detected in the groundwater samples. The only metals detected in the regional groundwater above 1994 regulatory standards were lead (one occurrence) and selenium. Dissolved lead was detected above its 1994 regulatory limit in groundwater from Regional Well HMW-29, but total lead was not detected in this sample. Lead was not detected above regulatory standards in soil or vadose zone water at these SWMUs. Selenium was detected above regulatory standards in regional groundwater at SWMUs 38 and 39, but selenium was not detected above regulatory standards in soil from this area.

Upon review of the Phase II RFI Report, the USEPA and NMED required additional monitoring of groundwater conditions at this location. The USEPA required that the source of impacts to the upper groundwater zone should be verified and the source of release should be addressed prior to evaluating remedial options. The NMED required that WSMR implement a monitoring plan and determine if any connection exists between the vadose zone water and underlying Regional Aquifer. Additionally, the NMED stated that caps on the landfills were not compliant with the specifications of the New Mexico Solid Waste Management Regulations. The NMED required that the landfill caps be upgraded (Kelley, 1996). As specified by the NMED in correspondence dated June 6, 2000, the NMED stated that the units must undergo closure and post-closure care under the provisions of 20 NMAC 4.1.600 (Dinwiddie, 2000).

Phase III RFI

A new regional zone monitoring well (HMW-59) was installed and sampled downgradient of the SWMUs to determine whether the regional groundwater had been

impacted. An additional seven existing wells (Regional Wells HMW-29, HMW-30, HMW-32, HMW-34, and HMW-35, and Vadose Zone Wells HMW-31 and HMW-33) were sampled for water quality parameters, dissolved ions, hexavalent chromium, RCRA metals, VOCs, SVOCs, TPH-DRO, TPH-GRO, and TOC. No soil borings were completed.

During the Phase III RFI sampling activities in December 2006, the depth to vadose zone water was between 42.7 and 44.4 feet. Depth to water in the regional wells ranged from 73.6 to 75 feet. Chromium, selenium, chloride, fluoride, sulfate, and 1,1-DCE were detected above their respective NMED Groundwater Standards, and TCE wasere detected above the EPA MCL regulatory action levels in the vadose zone water from HMW-31 and HMW-33. Generally, chloride, fluoride, nitrate, sulfate, and TDS were detected above the NMED Groundwater Standards in the regional groundwater wells sampled during the Phase III RFI, including in the newly installed downgradient well HMW-59. Total and dissolved selenium were detected above the NMED Groundwater Standard in groundwater from HMW-35, and 1,4-Dioxane was detected in groundwater from HMW-32 above the NMED Tapwater Standard. In addition, total and dissolved molybdenum have been detected above the NMED Tapwater Standard in groundwater from HMW-35. Chloroform was also detected in vadose zone water, but below the regulatory action levels. With the exception of one detection of selenium that was detected above the regulatory action level in groundwater from HMW-35, only chloride, fluoride, and sulfate were detected in regional groundwater in the vicinity of SWMUs 38 and 39, including detections in the newly installed downgradient Regional Well HMW-59.

6.10.5 Nature and Extent of Contamination

The soil sample locations for SWMUs 38 and 39 (ConstructionHELSTF Landfills) are shown on Figure 6.10-1. A table presenting aAll soil analytical data used for the evaluation of this these SWMUs isare presented in Table 6-9108 in Appendix D-2.

6.10.5.1 *VOCsShallow Soil (0 to 10 ft bgs)Table 6.10-1 provides a statistical summary of data for shallow soil and Table 6.10-2 provides a summary of exceedances of regulatory standards for shallow soil at SWMUs 38 and 39. .*

6.10.5.1.1 Shallow Soil (0 to 10 ft bgs) VOCs

There were no VOCs detected above the NMED SSLs for residential soils or the DAF 10 criteria in shallow soils at SWMUs 38 and 39.Acetone was the only VOC detected in

~~shallow soil (• 10 ft bgs) at SWMUs 38 and 39. There was only one detection of acetone in the 21 samples designated for this analysis, at 0.0342 mg/kg at SWMU 38-39 SB-03 (4 ft bgs). Acetone is a common laboratory artifact and the detection is likely attributable to laboratory contamination. Additionally, it should be noted that this acetone detection is isolated to one sample collected at these SWMUs. Due to these conditions, the detection is not being attributed to soil conditions at SWMUs 38 and 39 and acetone is not considered a COPC associated with these SWMUs.~~

6.10.5.1.2 Deep Soil (Greater than 10 ft bgs)

Chloroform was the only VOC detected above the NMED DAF 10 criterion in deep soil at SWMUs 38 and 39. Chloroform was detected at an estimated concentration of 0.0067 mg/kg at HMW-34 (59 ft bgs), which exceeds the NMED DAF 1 screening value of 0.000412 mg/kg (~~Figure 6.10-1~~). This occurrence of chloroform is isolated to this location and has been delineated (Figure 6.10-2 and Figure G-1 in Appendix ~~Figure~~G-~~1~~). It should be noted that chloroform has occurred in vadose zone water from HMW-31 and HMW-33, at concentrations below the NMED Groundwater Standard. Vadose zone water is encountered at approximately 41 to 45 ft bgs in this area. Therefore, the detection of chloroform at 59 ft bgs could be more representative of vadose zone water conditions than soil conditions. It should be noted that chloroform has not been detected in regional groundwater from HMW-34.

6.10.5.2 *SVOCs*

~~6.10.5.1.2~~6.10.5.2.1 Shallow Soil (0 to 10 ft bgs) ~~VOCs~~

No SVOCs were detected above the NMED SSLs or the DAF 10 criteria in shallow soil at SWMUs 38 and 39.~~The only SVOC detected in shallow soils (• 10 ft bgs) at SWMUs 38 and 39 was BEHP. BEHP was detected in only 1 of the 21 shallow soil samples designated for this analysis. BEHP was detected at 0.438 mg/kg at SWMU 38-39 SB-04 (4 ft bgs). BEHP is a common laboratory artifact and the detection is likely attributable to laboratory contamination. Additionally, it should be noted that this BEHP detection is isolated to one sample collected at these SWMUs. Due to these conditions, the detection is not being attributed to soil conditions at SWMUs 38 and 39 and BEHP is not considered a COPC associated with these SWMUs.~~

6.10.5.2.2 Deep Soil (Greater than 10 ft bgs)

No SVOCs were detected above the DAF 10 criteria in deep soil at SWMUs 38 and 39.

~~6.10.5.2~~6.10.5.3 *Other Parameters*

6.10.5.3.1 Shallow Soil (0 to 10 ft bgs)

TPH were detected in only 2 of the 15 soil samples analyzed for them. An elevated concentration (999 mg/kg) of TPH was detected at a depth of 4 ft in SWMU 38-39 SB-04. ~~Concentrations of TPH were detected in 2 of the 15 shallow soil samples designated for these analyses.~~ Samples that were tested for TPH were also tested for full suites of VOCs and SVOCs that would comprise the TPH. ~~The isolated VOC and SVOC concentrations previously described are being attributed to laboratory contamination.~~ No other organic ~~compounds~~ COPCs were detected above screening standards. These conditions confirm that TPH is not a risk to potential receptors.

6.10.5.3.2 Deep Soil (Greater than 10 ft bgs)

Concentrations of TPH were detected in 2 of the 36 deep soil samples designated for these analyses. TPH were detected at 43.3 mg/kg at SWMU~~s~~ 38 ~~and~~ 39 SB-04 (12 ft bgs) and at 40.0 mg/kg at SWMU~~s~~ 38 ~~and~~ 39 SB-05 (14 ft bgs). It should be noted that the concentration of TPH at 12 ft bgs at SB-04 indicates a significant decrease in concentrations from that detected at 4 ft bgs (999 mg/kg). TPH occurrences in deep soil at concentrations below 45 mg/kg do not pose a risk to potential receptors.

~~6.10.5.3~~6.10.5.4 *Metals*

6.10.5.4.1 Shallow Soil (0 to 10 ft bgs)

No metals identified as COPCs were detected at concentrations that exceeded the NMED SSLs for residential soil in shallow soils at SWMUs 38 and 39. Two silver detections exceeded the DAF 10 criterion in shallow soil at these SWMUs. Both silver DAF 10 exceedances occurred at SWMU~~s~~ 38 ~~and~~ 39 SB-08; 32.9 mg/kg was observed at a depth of 4 ft bgs, while a concentration of 38.6 mg/kg was observed at a depth of 9 ft bgs. Silver exceedances of the DAF 10 criterion occur in deeper soils at SWMU~~s~~ 38 ~~and~~ 39 SB-08, as described in the following section. The occurrences of silver at SWMUs 38 and 39 are depicted on Figure 6.10-3. Silver exceedances in shallow soil have been delineated in this area, as shown on Figure G-2 in~~on~~ Appendix ~~Figure~~ G-~~2~~.

6.10.5.4.2 Deep Soil (Greater than 10 ft bgs)

Silver was the only metal identified as a COPC detected in deep soil at SWMUs 38 and 39. Silver was detected in ~~10~~7 of the 36 deep soil samples designated for this analysis at concentrations exceeding the NMED DAF 10 screening value. As shown on Figure 6.10-3, detections of silver exceeding the NMED DAF 10 screening value of 1.57 mg/kg were identified at the following locations: HMW-29 (18~~, 38,~~ and 78 ft bgs), HMW-31 (19 ft bgs), HMW-32 (79 ft bgs), HMW-34 (19 ft bgs), ~~HMW-35 (19 and 39 ft bgs),~~ and SWMU 38-39 SB-08 (14 and 19 ft bgs). The maximum detection of silver was 47.5 mg/kg, identified at SWMU 38-39 SB-08 at a depth of 19 ft bgs. The general delineation of silver in deep soil at the HELSTF is depicted on Figure G-3 in Appendix ~~Figure~~ G~~-3~~. ~~Arsenic, barium, cadmium, lead, mercury, selenium, and silver were all detected in shallow soils at SWMUs 38 and 39. As discussed previously, detections of arsenic, barium, and selenium do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained these constituents. The arsenic, barium, and selenium detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMUs 38 and 39.~~

~~Lead was detected in 6 of the 21 shallow soil samples, and mercury was detected in 3 of the 21 shallow soil samples designated for these analyses. Neither of these metals was detected in shallow soils at concentrations exceeding their respective NMED SSLs, for residential soil, and mercury was not detected above its NMED DAF 1 screening value. There is no DAF 1 screening value for lead.~~

~~Cadmium was detected in only 1 of the 21 shallow soil samples designated for this analysis. This detection of 5.81 mg/kg occurred at Phase II RFI background sample location 3839HA01. As indicated in Table F-5 in the Background Characterization Study (Appendix F), this cadmium concentration was equivalent to the BSL and is, therefore, not an exceedance of a regulatory standard.~~

~~Silver was detected in 2 of the 21 shallow soil samples designated for this analysis. Neither of these silver detections exceeded the NMED SSL (391 m/kg), but both detections exceeded the NMED DAF 1 screening value (1.47 mg/kg). Both silver DAF 1 exceedances occurred at SWMUs 38 and 39 SB-08; 32.9 mg/kg was observed at a depth of 4 ft bgs, while a concentration of 38.6 mg/kg was observed at a depth of 9 ft bgs. Silver exceedances of the DAF 1 occur in deeper soils at SWMUs 38 and 39~~

SB-08, as described below. The occurrences of silver are depicted on Figure 6.10-2. Silver exceedances in shallow soil have been delineated in this area.

6.10.5.3.1 Shallow Soil Summary

In summary, silver was the only COPC detected in shallow soils at SWMUs 38 and 39 at concentrations exceeding a regulatory standard. Two silver detections in soil from SB-08 exceeded the NMED DAF 1 screening value.

6.10.5.4 *Deep Soil (Greater than 10 ft bgs)*

Table 6.10-3 provides a statistical summary of data for deep soil and Table 6.10-4 provides a summary of exceedances of regulatory standards for deep soil at SWMUs 38 and 39.

6.10.5.4.1 VOCs

Acetone and chloroform were the only VOCs detected in deep soils (>10 ft bgs) at SWMUs 38 and 39. Acetone was detected in 4 of the 36 deep soil samples designated for this analysis at concentrations below the NMED DAF 1 standard. Acetone is a common laboratory artifact and these detections are likely attributable to laboratory contamination. Therefore, the detections of acetone are not attributed to soilconditions at SWMUs 38 and 39 and acetone is not considered a COPC associated with these SWMUs.

6.10.5.4.2 Chloroform was detected in only 1 of the 36 deep soil samples designated for this analysis. Chloroform was detected at 0.0067 mg/kg at HMW-34 (59 ft bgs), which exceeds the NMED DAF 1 screening value of 0.000412 mg/kg (Figure 6.10-3). This occurrence of chloroform is isolated to this location and has been delineated. It should be noted that chloroform has occurred in vadose zone water from HMW-31 and HMW-33, at concentrations below the regulatory standard. Chloroform has not been detected in regional groundwater from HMW-34.SVOCs

6.10.5.4.3 BEHP was the only SVOC detected in deep soils (>10 ft bgs) at SWMUs 38 and 39. BEHP was detected in only 1 of the 34 deep soil samples designated for this analysis, at 0.465 mg/kg at SWMUs 38 and 39 SB-07 (4 ft bgs), well below the NMED DAF 1 screening value (1,070 mg/kg). BEHP is a common laboratory artifact and this detection is likely attributable to laboratory contamination. In addition, this detection is limited to one sample collected from this area. Therefore, the detection of BEHP is not attributed to soil conditions at SWMUs 38 and 39 and BEHP is not considered a COPC associated with these SWMUs.Other Parameters

Concentrations of TPH were detected in 2 of the 36 deep soil samples designated for these analyses. TPH were detected at 43.3 mg/kg at SWMUs 38 and 39 SB-04 (12 ft bgs) and at 40.0 mg/kg at SWMUs 38 and 39 SB-05 (14 ft bgs). It should be noted that the concentration of TPH at 12 ft bgs at SB-04 indicates a significant decrease in concentrations from that detected at 4 ft bgs (999 mg/kg). Samples that were tested for TPH were also tested for full suites of VOCs and SVOCs that would comprise the TPH. The isolated VOC and SVOC concentrations previously described are not related to TPH. No other organic compounds were detected above screening standards. These conditions confirm that TPH is not a risk to potential receptors.

6.10.5.4.4 Metals

Arsenic, barium, chromium, lead, mercury, selenium, and silver were all detected in soil samples collected from deeper than 10 ft bgs at SWMUs 38 and 39. As discussed in Section 4.3.6 (page 38), detections of arsenic, barium, and selenium do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained these constituents. The arsenic, barium, and selenium detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMUs 38 and 39.

Silver was detected in 10 of the 36 deep soil samples designated for this analysis at concentrations exceeding the NMED DAF 1 screening value. As shown on Figure 6.10-2, detections of silver exceeding the NMED DAF 1 screening value of

~~1.57 mg/kg were identified at the following locations: HMW-29 (18, 38, and 78 ft bgs), HMW-31 (19 ft bgs), HMW-32 (79 ft bgs), HMW-34 (19 ft bgs), HMW-35 (19 and 39 ft bgs), and SWMU 38-39 SB-08 (14 and 19 ft bgs). The maximum detection of silver was 47.5 mg/kg, identified at SWMU 38-39 SB-08 at a depth of 19 ft bgs.~~

~~The other metals detected in deep soil at SWMUs 38 and 39 occurred as follows: chromium was detected in 13 of 36 samples, lead was detected in 25 of 36 samples, and mercury was detected in 2 of 26 samples. None of these metals were detected at concentrations exceeding their respective NMED DAF 1 screening values.~~

6.10.5.5 ~~*Deep Soil*~~ *Summary*

The VOC chloroform was detected in one deep soil sample at a concentration exceeding the NMED DAF 10 screening value. The detection was isolated to one location (HMW-34 at 59 ft bgs). Chloroform was not detected in the regional groundwater collected from HMW-34. The isolated chloroform detection has been delineated. ~~Silver was detected in ten samples above the NMED DAF 1 screening value.~~

Silver exceedances of the DAF 10 screening values were delineated vertically at HMW-31~~, HMW-35,~~ and HMW-34 The lateral distributions of silver in the area of the HELSTF landfills in shallow and deep soil are shown on ~~Appendices~~Figures G-2 and G-3, respectively, in Appendix G The depth to groundwater in Regional Well HMW-29 in 2009 was 73.45 ft bgs and the depth to groundwater in Regional Well HMW-32 was 73.32 ft bgs. Therefore, the deepest samples at these locations were below the regional groundwater table and the silver exceedances in soil at HMW-29 and HMW-32 were~~as~~ delineated vertically throughout the soil column. Although silver was detected in shallow and deep soils above the ~~regulatory~~NMED DAF 10 standard, it was not detected in vadose zone water from HMW-31 or HMW-33 or in regional groundwater from HMW-29, HMW-30, HMW-32, HMW-34, or HMW-35.

6.10.6 Human Health Risk Assessment Findings

Data collected during site characterization activities during the RFIs were used in the evaluation of risk to human health. A description of risk assessment methodologies and results is provided on page 104 of Appendix E.

The results of the human health risk assessment data screening process indicate that after comparison to health-based soil screening levels for industrial worker exposure,

residential exposure, and construction worker exposure, no COPCs were selected for surface soil, or for combined surface and subsurface soil at SWMUs 38 and 39. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMUs 38 and 39 are unlikely to result in adverse health impacts to the identified current and potential future receptors. Additionally, no COPCs were selected for saturated vadose zone soil water and total soil at SWMUs 38 and 39, indicating that vapor intrusion is unlikely to result in adverse health impacts. Based on these results, additional human health risk assessment is not warranted for SWMUs 38 and 39.

~~6.10.6.1 *Soil Exposure Scenarios*~~

~~In accordance with NMED guidance (NMED, 2006a), constituent concentrations in surface soil and in combined surface and subsurface soil were compared to health-based screening levels and the calculated ratios summed. The total ratios were less than the NMED target ratio of 1. The results of this data screening process indicate that after comparison to health-based SSLs for industrial worker exposure, residential exposure, and construction worker exposure, no COPCs were selected for surface soil or for combined surface and subsurface soil at SWMUs 38 and 39. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMUs 38 and 39 are unlikely to result in adverse health impacts to the following potential receptors via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, dermal):~~

- ~~Current and future site workers;~~
- ~~Future residents (adults and children); and~~
- ~~Future construction workers.~~

~~6.10.6.2 *Vapor Intrusion Scenarios*~~

~~The results of this data screening process indicate that after comparison to health-based screening levels for protection of indoor air, no COPCs were selected for saturated vadose zone water and total soil at SWMUs 38 and 39. This demonstrates that the constituent concentrations in saturated vadose zone water and total soil at SWMUs 38 and 39 are unlikely to result in adverse health impacts to the following potential receptors via inhalation of indoor air:~~

- ~~Future site workers; and~~

- ~~Future residents (adults and children).~~

6.10.7 Ecological Risk Assessment Findings

A SLERA and BERA were completed for SWMUs 38 and 39. After the SLERA, one constituent (i.e., lead) was selected as a COPEC in surface soil and four constituents [bis (2-ethylhexyl)phthalate, lead, silver, and selenium] were selected as COPECs in combined surface and subsurface soil because their HQs were greater than 1. In the BERA, lead in surface soil, and lead and selenium in combined surface and subsurface soil were retained for further evaluation in the food chain modeling since they were identified as bioaccumulative.

Tables E.7.ERA-20 and E.7.ERA-21 (of Appendix E) summarize the COPECs in surface soil and combined surface and subsurface soil that were carried through the BERA and evaluated in the terrestrial food chain model. As shown in these tables, all receptors evaluated in the terrestrial food chain refined scenarios had LOAEL and NOAEL HQs less than or equal to 1. Based on the overall analysis of the ERA for SWMUs 38 and 39, the results indicate that if exposure were to occur, then adverse effects are not expected for wildlife that may access the site.

~~As described in the ERA presented on page 98 of Appendix E, screening-level and baseline risk assessments were completed for SWMUs 38 and 39. After the SLERA, one constituent (i.e., lead) was selected as a COPEC in surface soil and four constituents [BEHP, lead, silver, and selenium] were selected as COPECs in combined surface and subsurface soil because their HQs were greater than 1. In the BERA, lead in surface soil and lead and selenium in combined surface and subsurface soil were retained for further evaluation in the food chain modeling because they were identified as bioaccumulative.~~

~~Tables E.7.ERA-20 and E.7.ERA-21 of Appendix E summarize the COPECs in surface soil and combined surface and subsurface soil that were carried through the BERA and evaluated in the terrestrial food chain model. As shown in these tables, all receptors evaluated in the terrestrial food chain refined scenarios had LOAEL and NOAEL HQs less than or equal to 1. Based on the overall analysis of the ERA for SWMUs 38 and 39, the results indicate that if exposure were to occur, adverse effects are not expected for wildlife that may access the site.~~

6.10.8 Conclusions and Recommendations

No COPCs were detected in the upper 10 feet of soil at SWMUs 38 and 39 above their SSLs. Based on the data collected for SWMUs 38 and 39, the only COPCs detected in soils above their respective NMED DAF 10 screening values were chloroform and silver. There was only one detection of chloroform at a depth of 59 ft bgs; it was not detected in shallower soils or at any other locations at these SWMUs. In addition, chloroform was not detected above ~~regulatory~~the NMED Groundwater S~~s~~tandard~~s~~ in vadose zone water at SWMUs 38 and 39, and was not detected in regional groundwater in this area. Silver was detected above its DAF 10 screening value in shallow and deep soils at SWMUs 38 and 39. These detections have been delineated and there have been no silver impacts to vadose zone water or regional groundwater in the area.

~~The results of this data screening process indicate that after comparison to health-based SSLs for industrial worker exposure, residential exposure, and construction worker exposure, no COPCs were selected for surface soil or for combined surface and subsurface soil at SWMUs 38 and 39. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMUs 38 and 39 are unlikely to result in adverse health impacts to the identified current and potential future receptors. Additionally, no COPCs were selected for saturated vadose zone water and total soil at SWMUs 38 and 39, indicating that vapor intrusion is unlikely to result in adverse health impacts. Based on these results,~~ The findings of the HHRA screening (Appendix E) indicated that additional HHRA is not warranted for SWMUs 38 and 39. ~~A SLERA and BERA were completed for SWMUs 38 and 39 to evaluate surface soil and subsurface soil for ecological receptors, and food chain modeling was evaluated for all the constituents identified as bioaccumulative.~~ The results of the SLERA and BERA for direct contact and the constituents evaluated in the terrestrial food chain models indicate there is adequate information to conclude that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in soil. Therefore, no further ecological evaluation at SWMUs 38 and 39 is warranted.

The conditions at these SWMUs have been adequately characterized. No restrictions need to be applied to current or potential future land use at the site. Based upon these conditions, no further investigations of SWMUs 38 and 39 are warranted. However, based upon comments received from NMED in Years 1996 and 2000, additional closure activities for these SWMUs may be necessary. Therefore, an evaluation pertaining to applicable closure and post-closure care requirements will be conducted

in order to establish the appropriate administrative procedure needed to obtain final closure.

6.11 SWMU 141 – Equipment Storage Area (WSMR-83)

6.11.1 Unit Description

This unit is located 500 feet south of the LSTC in the HELSTF area. The storage area consists of a fenced, asphalt-paved yard that is approximately 1.2 acres in size. ~~The yard was unpaved until 1990.~~ Currently, the area is used for surface storage of various equipment and materials to support the HELSTF operations.

6.11.2 Operational History

The Equipment Storage Area (SWMU 141) was established sometime in 1981 for use to support construction associated with the HELSTF facilities; it is still an active equipment and materials storage area. Prior to that time, it was the location of the MAR Waste Stabilization Pond (SWMU 148). Originally, the yard was unpaved. A previously unknown release of Entec 300 (a chromate solution) was discovered in the northeastern corner of the yard during the excavation of the storage yard in preparation for paving in December 1989 (Hayslett, 1990). During 1990, following the completion of an extensive soil sampling investigation to determine if chromates had been released in the yard, the area was paved with asphalt.

For limited periods in the past, in addition to the storage of equipment and materials, chemicals, scrubber liquors, and waste oils were stored in containers in this area. The eastern end of this SWMU is underlain by the former MAR Waste Stabilization Pond (SWMU 148), and the northeastern corner of this SWMU abuts the unpaved area known as the HELSTF Storage Yard Chromiumate Spill AreaSite (SWMU 143) (Figure 6.11-1).

The potential contaminants associated with SWMU 141 may include waste oils and solvents. Table 21-1 provides lists of potential contaminants and associated with the SWMUs at the HELSTF and the indicator parameters used to evaluate potential impacts from these contaminants. Potential contaminants representative of solvents used at the HELSTF include 2-butoxy ethanol, t-butyl alcohol, Freon 113, isopropyl alcohol, methylene chloride, MEK, toluene, 1,1,1-TCA, and xylene. Indicator parameters for waste oils include PAHs, PCBs, lead, and chlorinated solvents.

6.11.3 Regulatory History

The USAEHA conducted an evaluation of environmental conditions at the HELSTF in July 1990. The investigation conducted as part of this survey provided the first account of SWMU 141. ~~As further described under Section 6.11.4 (Investigation History, page 38), s~~Surficial soil samples were collected in the area for analyses of chromium. Based upon the information provided in the USAEHA Report, SWMUs 141, 143, and 148 were incorporated into the RCRA Permit for investigation as Appendix IV sites (Davis, 1991a).

~~As further described under Section 6.11.4 (Investigation History, page 38),~~ SWMU 141 was investigated as part of the Phase I RFI. Based upon the results of the Phase I RFI, no further investigation of this SWMU was recommended. In response to this recommendation, WSMR requested a Class III permit modification to the RCRA Permit on October 12, 1993, to list the SWMU as a unit that requires NFA under the RFI process. On January 12, 1995, the USEPA issued a Statement of Basis/Final Decision and Response to Comments Summary, approving the NFA request (Harris, 1995). NMED accepted the NFA on August 6, 1999, and the unit was removed from the WSMR, 1998 Annual Unit Audit Fee Assessment. However, SWMU 141 is listed in the facility's current (December 2009) RCRA permit as a SWMU requiring corrective action.

No Phase II or III activities were conducted at this SWMU. In correspondence dated July 18, 2006, NMED requested that three soil borings be collected from sites south and west of the SWMU. ~~The area~~SWMU 141 overlies SWMU 148 and is immediately adjacent to SWMU 143. SWMU 141 was investigated in conjunction with those sites.

6.11.4 Investigative History

As stated previously, a USAEHA survey was conducted in 1990 and a Phase I RFI was conducted in 1992 at SWMU 141; no other RFIs were conducted at this SWMU. ~~summary of monitoring points used to investigate SWMU 141 is provided in Table 9 of Appendix D-2~~ Descriptions of these assessments are provided below.

USAEHA Survey

The USAEHA conducted a survey in the area of Equipment Storage Area during 1990. The results of the survey were provided in a report entitled *Ground-Water Quality Survey No. 38-26-0368-90, High Energy Laser Systems Test Facility, White Sands*

Missile Range, New Mexico, 23-27 July 1990, dated September 20, 1990. The survey of this area was conducted to determine if chromates had been released at any other point in the yard.

As part of this investigation, the area was divided into 122 cells. Eighteen of the cells were randomly selected for visual inspection. A sample of surficial soil was also collected from each of the selected cells for analyses of chromium. Sample results did not indicate detection of chromium in the surficial soil samples (USAEHA, 1990). The report recommended that further investigation of this area should be conducted as part of the Phase I RFI.

Phase I RFI

As part of the Phase I RFI, 14 shallow soil samples (3 to 7.5 ft bgs) and 1 shallow background soil sample (2 ft bgs) were collected for chemical analyses. Soil samples were analyzed for VOCs, SVOCs, PCBs/pesticides, TPH, and metals.

No visual evidence of contamination was observed during the soil sampling activities. The Phase I RFI reported that ~~A~~arsenic was detected in 10 of the 14 investigation samples and barium was detected in four of the investigation samples and that these ~~at~~ concentrations were representative of background. Acetone was detected in five of the samples at concentrations ranging from 0.17 to 0.72 mg/kg, but the Phase I RFI report indicated that it was introduced to the samples during sample collection. A trace concentration of BEHP was detected in one sample. This BEHP occurrence was likely due to laboratory contamination. No other constituents were detected in shallow soils at the unit.

Based upon these conditions, no further investigation of this SWMU was recommended in the RFI Report. As previously described under Section 6.11.3 (Regulatory History, page 180), the USEPA and NMED approved an NFA status for SWMU 141.

Phase II RFI

No activities were completed at SWMU 141 as part of the Phase II RFI.

Phase III RFI

No Phase III RFI activities were conducted at this SWMU. In correspondence dated July 18, 2006, NMED requested that three soil borings be collected from sites south and west of the SWMU (WTS, 2006). The SWMU 141 area contains two other SWMUs (143 and 148) and was investigated as it pertains to those sites. Borings HLSF-0085-SB-037, HLSF-0085-SB-038, and HLSF-SB-039 were advanced to 50 ft bgs and soil samples were collected from approximately every 10 feet from each boring. Surface samples were not collected due to the asphalt or concrete covering the site. Soil samples were analyzed for RCRA 8 metals, VOCs, TPH-DRO, and TPH-GRO. No VOCs or TPH were detected in soil from these three borings. With the exception of arsenic, which is naturally occurring, no other metals were detected above the regulatory standards in soil from these borings. There were no detections of cadmium, mercury, selenium, or silver in soil from these borings. Barium, chromium, and lead were detected in all of the samples collected from all three borings, but at concentrations below regulatory standards. Arsenic was detected above regulatory standards at 40 to 41 ft bgs and 49 to 50 ft bgs at HLSF-0085-SB-037 and at 20 to 21 ft bgs at HLSF-0085-SB-038.

6.11.5 Nature and Extent of Contamination

The borings used for this evaluation are associated with SWMUs 141, 143, and 148 (Figure 6.11-1). A table presenting aAll soil analytical data used for the evaluation of this SWMU isare presented in Table 6-110 9 of Appendix D-2.

6.11.5.1 *Shallow Soil (0 to 10 ft bgs)*VOCs*A total of 55 shallow soil (• 10 ft bgs) samples from 29 locations were evaluated for SWMU 141. Table 6.11-1 provides a statistical summary of data for shallow soil and Table 6.11-2 provides a summary of exceedances of regulatory standards for shallow soil at SWMU 141.*

6.11.5.1.1 VOCsShallow Soil (0 to 10 ft bgs)

No VOCs were detected above the NMED SSLs for residential soil or the DAF 10 criteria in shallow soil at SWMU 141.Two VOCs were detected in shallow soils at SWMU 141 as follows: acetone in 6 of 46 samples and methylene chloride in 4 of 43 samples. These VOCs are common laboratory artifacts and the detections are likely attributable to laboratory contamination. Additionally, it should be noted that these detections are isolated to only a few samples collected at this SWMU. Therefore, the

~~detections of acetone and methylene chloride are not being attributed to soil conditions at SWMU 141, and they are not considered COPCs associated with this SWMU.~~

6.11.5.1.2 Deep Soil (Greater than 10 ft bgs)

No VOCs were detected above the DAF 10 criteria in deep soil at SWMU 141.

6.11.5.2 *SVOCs*

6.11.5.2.1 Shallow Soil (0 to 10 ft bgs)

No SVOCs were detected above the NMED SSLs for residential soils or the DAF 10 criteria in shallow soil at SWMU 141. ~~The only SVOCs detected in shallow soil at SWMU 141 were BEHP in one sample (141B8, 3 ft bgs) and di-n-butyl phthalate in one sample (148SB-02, 8 ft bgs). The detected concentrations were below NMED SSLs for residential soils and the NMED DAF 1 value. Phthalates are common laboratory contaminants and are likely attributable to laboratory contamination. Therefore, the phthalate detections at SWMU 141 are not attributable to soil conditions at SWMU 141 and they are not considered COPCs associated with this SWMU.~~

6.11.5.2.2 Deep Soil (Greater than 10 ft bgs)

No SVOCs were detected above the DAF 10 criteria in deep soil at SWMU 141.

6.11.5.3 *Metals*

6.11.5.3.1 Shallow Soil (0 to 10 ft bgs)

With the exception of arsenic, which is attributable to redox-related conditions at the HELSTF, no metals were detected above the NMED SSLs for residential soil. Silver was detected above the DAF 10 criterion in 10~~2~~ of the~~45~~ shallow soil samples analyzed in vicinity of SWMU 141. as follows: HMW-43 (9 ft bgs), SWMU 148 SB-01 (8 ft bgs), SWMU 148 SB-02 (4 and 8 ft bgs), SWMU 148 SB-03 (4 and 8 ft bgs), SWMU 148 SB-04 (1 ft bgs), SWMU 148 SB-05 (9 ft bgs), SWMU 148 SB-06 (1 ft bgs) , and SWMU 148 SB-08 (1 ft bgs). The occurrences of silver in soil in at and in the vicinity of SWMU 141 are shown on Figure 6.11-2.

The silver DAF 10 exceedances in shallow soils at SWMU 141 have been delineated laterally, as pictorially depicted in Appendix ~~Figure~~ G ~~in Appendix G~~. The silver

exceedances of the DAF 10 screening value at HMW-43, SWMU 148 SB-04, SWMU 148 SB-06, and SWMU 148 SB-08 have been delineated vertically at those locations. Boring locations SWMU 148-SB-01, SWMU 148 SB-02, SWMU 148 SB-03 and SWMU 148 SB-05 are surrounded by nearby borings where deeper soil samples do not have silver exceedances of the DAF 10 screening value (e.g., HLSF-SB-027, 141B14, SWMU 148 SB-04, SWMU 148 SB-08, HMW-11, 0143SB06, and SWMU 148 SB-06).

6.11.5.3.2 Deep Soil (Greater than 10 ft bgs)

Silver was the only metal detected above the DAF 10 screening criterion, and there was only one silver detection that exceeded the DAF 10 in deep soil (HMW-43, 18 ft bgs). This exceedance has been delineated vertically and laterally, as shown on Figure 6.11-2 and Figure G-3 in Appendix ~~Figure~~ G-~~3~~.

6.11.5.4 *Summary*

There were no COPC exceedances of the NMED SSLs for residential soil in shallow soils at SWMU 141. Only silver was detected above the DAF 10 criterion. The silver exceedances of DAF 10 in soils at SWMU 141 have been delineated laterally and vertically. Silver is not a known COPC associated with SWMU 141; however, it was retained for evaluation because its occurrence is not consistent with naturally occurring conditions. In addition, silver has not been detected above the NMED Groundwater Standard in the vadose zone water encountered at approximately 43 ft bgs in Well HMW-43 (~~Appendix D-2 Table 1~~Table 6-22). Based on soil sampling results and knowledge of current and past operations at SWMU 141, these exceedances of the DAF 10 screening criterion for silver are not indicative of a release from SWMU 141.~~Arsenic, barium, chromium, lead, mercury, and silver were detected in shallow soil samples evaluated for SWMU 141. As discussed in Section 4.3.6 (page 38), detections of arsenic and barium do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at theHELSTF that contained these constituents. The arsenic detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 141.~~

~~Chromium was detected in 2 of the 38 shallow soil samples, lead was detected in 15 of the 45 shallow soil samples, and mercury was detected in 3 of the 45 shallow soil samples designated for these analyses. None of the chromium, lead, or mercury detections in shallow soils at SWMU 141 exceeded their respective NMED SSLs, and none of the mercury detections exceeded the DAF 1 screening values. There are no~~

DAF 1 screening values for chromium or lead.Silver was detected in 12 of the 45 shallow soil samples designated for this analysis. None of the silver detections were above the NMED SSL, but all of them were above the NMED DAF 1 value (1.57 mg/kg) at the following locations evaluated for SWMU 141: HMW-43 (1, 3, and 9 ft bgs), SWMU 148 SB-01 (8 ft bgs), SWMU 148 SB-02 (4 and 8 ft bgs), SWMU 148 SB-03 (4 and 8 ft bgs), SWMU 148 SB-04 (1 ft bgs), SWMU 148 SB-05 (9 ft bgs), SWMU 148 SB-06 (1 ft bgs), and SWMU 148 SB-08 (1 ft bgs). The maximum silver detection was 74.6 mg/kg, identified at 8 ft bgs from SWMU 148 SB-01. The occurrences of silver in soil at and in the vicinity of SWMU 141 are shown on Figure 6.11-2.

The silver DAF 1 exceedances in shallow soils at SWMU 141 have been delineated laterally. The silver exceedances of the DAF 1 screening value at HMW-43, SWMU 148 SB-03, SWMU 148 SB-04, SWMU 148 SB-05, SWMU 148 SB-06, and SWMU 148 SB-08 have been delineated vertically at those locations. Boring locations SWMU 148-SB-01, SWMU 148 SB-02, and SWMU 148 SB-05 are surrounded by nearby borings where deeper soil samples do not have silver exceedances of the DAF 1 screening value (e.g., HLSF-SB-027, 141B14, SWMU 148 SB-04, SWMU 148 SB-08, and SWMU 148 SB-06).

6.11.5.3.1 Shallow Soil Summary

The silver exceedances in shallow soils at SWMU 141 have been delineated vertically. Silver is not a known COPC associated with SWMU 141; however, it has been retained for evaluation because its occurrence is not consistent with naturally occurring conditions. Silver has generally been delineated laterally in shallow soils in this area as shown on Figure G-1 in Appendix G.

6.11.5.4 *Deep Soil (Greater than 10 ft bgs)*

Table 6.11-3 provides a statistical summary of data for deep soil and Table 6.11-4 provides a summary of exceedances of regulatory standards for deep soil at SWMU 141.

6.11.5.4.1 VOCs

6.11.5.4.2 As shown on Figure 6.11-3, TCE was the only VOC detected in deep soil in the vicinity of SWMU 141. TCE was detected in only 1 of the 48 soil samples designated for this analysis, HMW-43 (49 to 50 ft bgs), at a concentration of 0.0403 mg/kg, which is above the NMED DAF 1 screening value (0.0001 mg/kg). This is an isolated detection of TCE in deep soils underlying SWMU 141, and TCE was not detected in shallow soils above this detection. The depth to water in Vadose Zone HMW-43 where the TCE deep soil exceedance of the DAF 1 occurred ranges from approximately 40 to 43 ft bgs. TCE has not been detected in vadose zone water from HMW-43. The occurrence of TCE in deep soils at this one location is not indicative of a release from SWMU 141.SVOCs

6.11.5.4.3 Di-n-octylphthalate was the only SVOC detected in deep soil in the vicinity of SWMU 141, and it was detected in only two samples, HLSF-SB-023 (49 to 50 ft bgs) and HLSF-SB-024 (40 to 41 ft bgs). Neither of these detections exceeded the NMED SSL for residential soil or the NMED DAF 1 value. Phthalates are common laboratory contaminants and are likely attributable to laboratory contamination. Therefore, the phthalate detections at SWMU 141 are not attributable to soil conditions at SWMU 141 and they are not considered COPCs associated with this SWMU.Metals

Eight metals were detected in deep soils at SWMU 141, including arsenic (detected in 19 of 47 samples), barium (detected in 45 of 47 samples), chromium (detected in 41 of 42 samples), copper (detected in 24 of 24 samples), lead (detected in 43 of 47 samples), silver (detected in 2 of 47 samples), sodium (detected in 24 of 24 samples), and zinc (detected in 24 of 24 samples). As discussed in Section 4.3.6 (page 38), detections of arsenic, barium, and sodium do not represent releases of waste constituents from the SWMUs or site processes and are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 141. None of the detections of chromium, copper, and zinc exceeded their respective DAF 1 screening values. There is no DAF 1 screening value for lead.

6.11.5.4.4 Silver was detected above the DAF 1 screening criterion of 1.57 mg/kg in two samples (18 and 38 ft bgs) from HMW-43. These exceedances have been delineated vertically and laterally. As stated previously, silver is not a known COPC associated with wastes managed at SWMU 141. Figure 6.11-2 depicts the silver exceedances over the DAF 1 screening value. Figure G-2 in Appendix G further demonstrates that silver in deep soils in the SWMU 141 area has been delineated laterally.Deep Soil Summary

In summary, the only COPC detected above regulatory standards at SWMU 141 was TCE (only one isolated occurrence in deep soils). Silver is not a COPC for

SWMU 141, but was detected above the screening criteria in two samples. Silver was evaluated in this discussion because it is not considered representative of naturally occurring conditions. Neither TCE nor silver were detected above regulatory standards in the vadose zone water encountered at approximately 40 to 43 ft bgs in Well HMW-43 (Appendix D-3 Table 1). TCE was detected above its regulatory criterion in vadose zone water from Well HMW-11; however, no TCE was detected in overlying soils from the boring advanced for the installation of HMW-11. Based on soil sampling results and knowledge of current and past operations at SWMU 141, these exceedances of DAF 1 screening criteria are not indicative of a release from SWMU 141. A more detailed description of vadose zone water and regional groundwater conditions is provided in Section 6.25 (page 38).

6.11.6 Human Health Risk Assessment Findings

6.11.6.1 *Data collected during site characterization activities during the RFIs were used in the evaluation of risk to human health. A description of risk assessment methodologies and results is provided on page 113 of in page 124 of Appendix E.Soil Exposure Scenarios*

- In accordance with NMED guidance (NMED, 2006a), constituent concentrations in surface soil and in combined surface and subsurface soil were compared to health-based screening levels and the calculated ratios summed. The total ratios were less than or equal to the NMED target ratio of 1. The results of this data screening process indicate that after comparison to health-based soil screening levels for industrial worker exposure, residential exposure, and construction worker exposure, no COPCs were selected for surface soil or for combined surface and subsurface soil at SWMU 141. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMU 141 are unlikely to result in adverse health impacts to the following potential receptors via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, and dermal): Current and future site workers;

- Future residents (adults and children); and

- Future construction workers.

6.11.6.2 *Vapor Intrusion Scenarios*

No VOCs were detected in total soil (i.e., vadose zone). Therefore, no soil COPCs were identified for the future vapor intrusion evaluation at SWMU 141. However, there

~~were four VOCs detected in shallow saturated vadose zone water that were identified as COPCs and carried forward into risk calculations. As summarized in Table E.8.HHRA-13 of Appendix E, the total ELCR values for the future vapor intrusion exposure pathway for the site worker scenario and for the residential scenario are within the acceptable target risk range of 10^{-6} to 10^{-4} for carcinogenic effects. The total HI values for the future vapor intrusion exposure pathway for the site worker scenario and for the residential scenario are below the benchmark of 1 for non-cancer hazard, indicating adverse non-carcinogenic effects are unlikely to occur.~~

~~6.11.6.3 *Overall HHRA Summary*~~

The results of the data screening process indicate that after comparison to health-based soil screening levels for industrial worker exposure, residential exposure, and construction worker exposure, no COPCs were selected for surface soil, or for combined surface and subsurface soil at SWMU 141. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMU 141 are unlikely to result in adverse health impacts to the identified current and potential future receptors. Additionally, no VOCs were selected as COPCs in soil, indicating that vapor intrusion from soil is unlikely to represent an exposure concern. However, four VOCs in the saturated vadose zone water were selected as COPCs for the vapor intrusion evaluation. The findings of the vapor intrusion evaluation indicate that potential future industrial or residential development of the site would result in potential indoor air exposures that are below the regulatory benchmarks for cancer risks and non-cancer hazards. Based on these results, additional human health risk assessment is not warranted for SWMU 141.

6.11.7 Ecological Risk Assessment Findings

As described in the ERA presented on page 126~~115~~ of Appendix E, a SLERA and BERA were completed for SWMU 141. After the SLERA, one constituent (i.e., silver) was selected as a COPEC in surface soil and two constituents (i.e., BEHP and silver) were selected as COPECs in combined surface and subsurface soil because the HQs were greater than 1. In the BERA, silver was retained for further evaluation in the food chain modeling because it was identified as bioaccumulative.

Tables E.8.ERA-20 and E.8.ERA-21 of Appendix E summarize the constituents in surface soil and in combined surface and subsurface soil that were carried through the BERA and evaluated in the terrestrial food chain model. As shown in these tables, all receptors evaluated in the terrestrial food chain refined scenarios had LOAEL and

NOAEL HQs less than or equal to 1 with the exception of the desert shrew, which had a refined HQ slightly above 1. However, the affected area of silver with refined HQs greater than 1 for the desert shrew has a very limited spatial extent (approximately 0.3 acre). Based on the overall analysis of the ERA for SWMU 141, the results indicate that if exposure to soil were to occur in the future, adverse effects are not expected for wildlife that may access the site.

It is important to reiterate here that the above assessment is for a hypothetical future scenario and only applies if the site was redeveloped and the asphalt covering removed. There are no ecologically significant current risks at SWMU 141 for the following:

- The site is currently covered by asphalt, which eliminates the exposure pathway for wildlife via a physical barrier; and
- The affected area is very limited in spatial extent (approximately 0.3 acre). Therefore, exposure by terrestrial wildlife is not expected to cause adverse impacts to exposed receptors.

6.11.8 Conclusions and Recommendations

SWMU 141 is currently used as an equipment and material storage area. Waste oils and solvents were stored in this area historically. With the exception of silver, no COPCs were detected in soil at SMWU 141. There is no historical information indicating that silver is a COPC associated with operations at SWMU 141. ~~There were no COPCs detected in the upper 10 feet of soil underlying the surface storage area and, with the exception of one isolated detection of TCE in deep soil, none of the COPCs associated with this SWMU were detected in soil samples collected beneath and in the vicinity of SWMU 141.~~ SWMU 141 has been fully characterized and there is no evidence of a release from this SWMU.

The HHRA results demonstrate that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMU 141 are unlikely to result in adverse health impacts to the identified current and potential future receptors. Additionally, no VOCs were selected as COPCs in soil, indicating that vapor intrusion from soil is unlikely to represent an exposure concern. The findings of the vapor intrusion evaluation for vadose zone water indicate that potential future industrial or residential development of the site would result in potential indoor air exposures that are below

the regulatory benchmarks for cancer risks and non-cancer hazards. Based on these results, additional human health risk assessment is not warranted for SWMU 141.

~~An HHRA was conducted to evaluate exposure to COPCs in surface soil, combined surface and subsurface soil, total soil, and saturated vadose zone water for site workers under current and future land-use conditions, and construction workers and residents (adult and child) under hypothetical future land-use conditions. The HHRA evaluation demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMU 141 are unlikely to result in adverse health impacts to the following potential receptors via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, and dermal):~~

- ~~Current and future site workers;~~
- ~~Future residents (adults and children); and~~
- ~~Future construction workers.~~

~~No soil COPCs were identified for the future vapor intrusion evaluation at SWMU 141. However, the four VOCs detected in shallow saturated vadose zone water were identified as COPCs for the future vapor intrusion evaluation, and were carried forward into risk calculations. The total ELCR values for the future vapor intrusion exposure pathway for the site worker scenario and for the residential scenario are below the acceptable target risk range of 10^{-6} to 10^{-4} for carcinogenic effects. The total HI values for the future vapor intrusion exposure pathway for the site worker scenario and for the residential scenario are below the benchmark of 1 for non-cancer hazard, indicating adverse non-carcinogenic effects are unlikely to occur.~~A SLERA and BERA were completed for SWMU 141 to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents detected in surface soil and combined surface and subsurface soil, and to conduct food chain modeling for the COPEC identified as bioaccumulative (i.e., silver). The results of the SLERA and BERA for direct contact exposure and for food chain modeling indicate there is adequate information to conclude that there are no significant current exposures to soil and future impacts are unlikely to occur for ecological receptors potentially exposed to constituents in soil. Therefore, no further ecological evaluation at SWMU 141 is warranted.

There are no environmental impacts associated with SWMU 141 as a result of historical site activities and no restrictions need to be applied to current or potential

future land use at the site. Accordingly, the site is recommended for NFA and should be closed out of the RCRA process.

6.12 SWMU 142 – HELSTF Cleaning Facility Sump (CCWS-05; WSMR-48)

6.12.1 Unit Description

The HELSTF Cleaning Facility Sump (SWMU 142) is located in the HCF, which is no longer an active facility. Operations conducted in ~~T~~the HCF ~~is responsible for~~ included washing and cleaning valves, pipes, and equipment for laser- and other support-related activities. ~~operations~~. The Cleaning Facility consists of a gross cleaning room (or Pre-Clean Room), Final Cleaning Room, Packaging Room, and storage shelters in a fenced storage yard and ~~has~~was ~~been~~ in operation ~~since~~from ~~-~~1983 through April 2009. The sump dimensions are 3 feet by 4 feet by 5 feet deep.

Prior to assembly, laser system hardware components were cleaned through a series of washing steps using five 1,000-gallon cleaning vats and a large Freon degreaser. Hardware components were also periodically re-cleaned after extensive use. Spent solvents and rinsate solutions/by-products were dumped from the cleaning vats to an open floor trench that drained to the sump in the Pre-Clean Room.

The primary contaminants removed by the cleaning operations include dust, breakdown products from laser operations, light grease, or oil (USAEHA, 1990). The potential waste types generated include solvents, acids, and detergents.

6.12.2 Operational History

The construction of the HCF was completed in 1982. Plumbing, wiring, and other internal construction activities were completed in March 1983. A 28,000-cubic-foot-per-minute fume scrubber system (SWMU 26) was installed for quality control and hygiene reasons. Testing of the scrubber system began in April 1983 and ~~full scale~~ operations at the HCF commenced in June 1983. The HCF became fully operational during the fall of 1985.

The spent solvents and cleaning solutions, poured from the vats, originally were pumped to a 2,100-gallon hazardous waste tank (SWMU 23) located outside of the building. Based on waste generation estimations, it was determined that it would be necessary to empty the tank every 6 months at a permitted disposal facility. However,

during the course of operations, the volume of waste generated at the HCF exceeded the anticipated volume.

In April 1985, a chemical waste evaporation system with a design flow rate of 3,400 gallons per week was constructed as a permanent solution to the generation of excess waste. As part of the design, a 4-inch double-walled pipeline, consisting of a 2-inch primary line with in a 4-inch secondary line, was constructed. The pipeline extended 1,000 feet from the existing Chemical Waste Tank (SWMU 23) to the manifold at the new Chemical Waste Tanks (SWMUs 31 and 32).

During the interim, a 5,000-gallon storage tank (SWMU 24) was used for the storage of hazardous waste in addition to the initial 2,100-gallon storage tank (SWMU 23). The tanks were periodically emptied and the waste was transported to NASA Whites Sands Test Facility (WSTF) for treatment and disposal. In addition to the cleaning solutions and solvents, scrubber water from the Vapor Recovery Unit (SWMU 26) was emptied into the sump when requiring a change-out.

The HELSTF Chemistry Laboratory was moved into the HCF annex after construction was completed between 1988 and 1989. The laboratory design included a double-walled drain line connected with the Chemical Waste Tanks (SWMUs 31 and 32) which provided for the disposal of small quantities of various chemical reagents via floor and sink drains.

As of late March/early April 2009, the HCF, where the sump (SWMU 142) was located, was no longer in use due to the cessation of chemical laser operations at the site.

The potential constituents of concern at SWMU 142 include CFC-113 (Freon), 1,1,1-TCA, 1,1-DCA, 1,1-DCE, ~~arsenic, lead, barium,~~ chromium, and diesel fuel constituents (related to SWMU 154).

6.12.3 Regulatory History

The HCF sump was not identified as a SWMU during the RFA in 1988. Due to this condition, the SWMU was not part of the initial RCRA Permit (September 1989). On May 26, 1989, WSMR notified the USEPA that a leak in the sump at the HCF had been discovered (Howell, 1989). The practice of emptying the vats of chemical waste to the open trench was immediately halted. The waste was subsequently managed by emptying the chemical waste directly from the vats into 55-gallon drums (Pannell,

1992). The drums were stored in the Waste Accumulation Area (SWMU 25) prior to disposal.

WSMR submitted an Interim Cleanup Plan on June 2, 1989, that included an initial investigation of the extent of contamination. The investigation was initiated in July 1989 and involved the removal of portions of the concrete sump, and sampling~~,~~ and excavation of contaminated soil. The activities were halted in September 1989 following removal of 54 cubic yards of soil. Further excavation could not be continued without threatening the integrity of the building foundation.

On September 11, 1989, the regulatory agency was notified after a leak was confirmed in the interstitial liner of the Chemical Waste Tanks (SWMUs 31 and 32). On September 26, 1989, the agency removed the Chemical Waste Tanks from the RCRA Permit application upon WSMR's request. The HCF sump was also removed from the application. Therefore, the HCF sump and chemical waste tanks were not included in the 1989 RCRA p~~P~~ermit ~~as result of these actions~~. SMWU 142 is listed in the facility's December 2009 RCRA permit as a hazardous waste management unit with closure required.

A ~~draft~~ contamination assessment plan was prepared in November 1989 that proposed to advance soil borings at four locations. The assessment plan proposed collection of soil samples from the surface to the top of the major clay unit (approximately 25 to 30 ft bgs)~~The plan also included~~ and the installation of a monitoring well at the south side of the HCF. The results of the investigation indicated detections of organics and Freon in soil samples and diesel as LNAPL in groundwater at the location of the newly installed monitoring well. A formal closure plan for the HELSTF treatment tank system was ~~also~~ submitted to the NMED in February 1990.

~~The assessment plan proposed to collect samples from the surface to the top of the major clay unit (approximately 25 to 30 ft bgs). The installation of a single monitoring well was also proposed at the south side of the HCF. The results of the investigation indicated detections of organics and Freon in soil samples and diesel as LNAPL in groundwater at the location of the newly installed monitoring well.~~During July 1990, the USAEHA conducted an evaluation at the HCF and determined that the release was attributed to damage to the floor trench drain pipe. The design of the drain did not include secondary containment of the drain pipe. As a result of the damage and design flaw, the USAEHA report concluded that rinsate by-product had been released to soil beneath the foundation over an un~~der~~determined period of time. The USAEHA designated the HCF Sump as SWMU 142 (USAEHA, 1990).

In November 1990, the structural integrity of the pipeline from the HCF to the Chemical Waste Tanks (SWMUs 31 and 32) was tested. The primary 2-inch line was determined to have structural integrity. The outer 4-inch secondary line failed the testing. The primary line from the HCF sump to the valve box was tested and failed. This section of pipe didoes not have secondary containment. The report for the investigation indicates that a release occurred beneath a concrete slab adjacent to the HCF sump (WSMR, 1991). The report also indicated that there were small leaks in the connections in the primary line between the HCF valve box and the Chemical Building Annex.

On January 8, 1991, the USEPA was notified that a diesel release was discovered during the HCF assessment. The diesel fuel release, reported in groundwater sampled at the newly installed monitoring wells, was attributed to a Systemic discharge of approximately 175,000 gallons of diesel fuel at SWMU 154 (HELSTF Systemic Diesel Spill Site).

During March 1991, a draft RFI Work Plan was prepared that proposed further assessment at the HCF. On June 28, 1991, NMED approved the HTTS Closure Plan, with modifications. On August 7, 1991, the USEPA approved a Class I Permit modification request to add SWMUs 140 through 158 as Appendix IV sites.

Site modifications to the HCF process occurred during 1991 that included process upgrades to the Pre-Clean Room to reduce the overall volume of waste generated. To accommodate the new equipment, the trenches in the Pre-Clean Room were filled with concrete, the cleaning vats and 1,1,1-TCA-degreaser were removed, and secondary containment was provided for each area to contain spills.

Corrective action activities at the HTTS began in November 1991. The activities related to the chemical waste tanks concluded in February 1992 with their removal and filling of the pipeline with concrete. In June 1992, the Phase I RFI field work was conducted. The report for the assessment indicated that significant impacts to soil and groundwater had been identified at SWMU 142 and that the conditions were commingled with wastes more likely associated with SWMU 154. Based upon these conditions, it was recommended that Phase II RFI activities for both SWMUs 142 and 154 be closely coordinated (ITC, 1992b).

~~In June 1992, the Phase I RFI field work was conducted. The report for the assessment indicated that significant impacts to soil and groundwater had been identified and that the conditions were co-mingled with wastes more likely associated~~

~~with SWMU 154. Based upon these conditions, it was recommended that Phase II RFI activities for both SWMUs 142 and 154 be closely coordinated (ITC, 1992b).~~A modification to the Closure Plan, initially submitted during February 1990, was submitted in 1992. The Closure Plan modification included conducting a hydrogeologic investigation and ~~to~~ commencinge ~~monitoring activities of the~~ vadose zone water monitoring around the HCF (Sisneros, 1992). The NMED approved the modification with the condition that WSMR submit a comprehensive monitoring plan for the HCF.

During October 1992, NMED concurred with WSMR's request to coordinate the combined activities to address:

- Closure of the Cleaning Facility Tank System (SWMUs 31 and 32);
- RFI Processes at the HCF (SWMU 142) and Systemic Diesel Spill (SWMU 154); and
- Interim response measure at SWMU 154.

As required by the NMED for the SWMU 142 Closure Plan, WSMR submitted the *Comprehensive Groundwater Sampling and Analysis Plan (SAP) of the High Energy Laser Systems Test Facility (HELSTF) Cleaning Facility* on November 25, 1992. The USGS has been conducting quarterly sampling of the well network since April 1994.

6.12.4 Investigative History

The sampling locations used to evaluate soil conditions as SWMU 142 are shown on Figure 6.12-1. ~~A summary of monitoring points used to investigate SWMU 142 is provided in Appendix D-2 Table 10. Soil sampling locations are shown on Figure 6.12-1.~~Descriptions of assessments are provided below.

Interim Cleanup Plan Investigation

The~~i~~s investigation was initiated in July 1989 and involved the removal of portions of the concrete sump, sampling, and excavation of contaminated soils in the area of the sump. The activities were halted in September 1989 after 54 cubic feet of soil had been removed and further investigation could not be conducted without damaging the foundation of the HCF building.

Contamination Assessment – 1990

The field program was conducted in March and April 1990 and included advancing soil borings at four locations to collect soil samples for analyses. The borings were advanced from the surface to the top of the major clay unit (approximately 25 to 30 ft bgs). A monitoring well was installed on the south side of the HCF.

Results of the assessment indicated detections of 1,1,1-TCA, 1,1-DCA, and 1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113). These detections were attributed to a release from the hazardous waste drain line (LESC, 1990). The investigation report indicated that 12 feet of diesel fuel was present in the subsurface at the location of the newly installed Monitoring Well HCF-01.

The diesel fuel was attributed to a release associated with SWMU 154.

Phase I RFI

Phase I RFI activities at the HCF included advancing three soil borings to 40 ft bgs and collecting groundwater from two monitoring wells at nearby SWMU 154. The field program was implemented in June 1992. Background data were collected from a boring advanced during April 1992. The assessment included collecting soil and groundwater samples for analyses of Freon constituents, VOCs, SVOCs, TPH, and metals.

The planned field investigation ~~called for three soil borings to 40 ft bgs with~~ included collection of soil samples ~~at~~from approximately every 5 feet from 10 ft bgs to 40 ft bgs in each of the three 40-ft soil borings, and collection of~~. G~~ groundwater ~~was also~~ samples~~collected from each of the wells~~. Samples were analyzed for VOCs, SVOCs, TPH, and metals.

- Groundwater data collected from three wells (HCF-01, HCF-02, and HCF-03) show the presence of NAPL attributed to releases from SWMU 154. Analyses of the NAPL showed high levels of phenanthrene, naphthalene, and TPH. Analyses of water beneath the NAPL also showed dissolved concentrations of these constituents as well as other VOCs and SVOCs, of which only benzene exceeded regulatory levels.

- Soils data indicated detections of metals (arsenic, barium, and lead) and several VOCs. Barium and lead were detected below ~~background~~ levels in the

background boring. The VOCs included 1,1-DCE, 1,1-DCA, TCE, and benzene, toluene, ethylbenzene, and xylenes (BTEX), all of which may be attributed to SWMU 142 and/or 1544~~7~~. Data indicated detections in soil samples collected at or near the total depth (40 ft bgs) of each boring.

- Analytical results of soil samples collected as part of the HCF closure indicated detections of organics that exceeded the toxicity characteristic standards (TCs). Concentrations of Freon were detected in one sample. Several metals were detected at concentrations that also exceeded TCs. Analyses of water collected from boreholes showed solvent constituent concentrations that greatly exceeded 1992 action levels.

As a result of the assessment, impacts to soil and groundwater were identified. However, due to the close proximity to SWMU 154 (HELSTF Systemic Diesel Spill), it was believed that the conditions at SWMU 142 were commingled with the plume from this unit. As a result of these conditions, it was recommended that any Phase II RFI activities be conducted in order to coordinate ~~with~~ closure activities planned for SWMU 142 and implementation of an Interim Corrective Measures Plan for SWMU 154.

Comprehensive Groundwater Sampling and Analysis Plan (SAP) of the High Energy Laser Systems Test Facility (HELSTF) Cleaning Facility.

The plan was approved on November 25, 1992. Four monitoring wells (CFW-01 through CFW-04) were installed as part of the SAP in May 1993. The USGS has been conducting quarterly sampling of the well network since April 1994. Other wells sampled as part of the program include DRW-06, HMW-10, HMW-13, HMW-36, HMW-37, and HMW-47.

Data collected as part of this program indicated detections of site constituents that include 1,1,1- TCA, 1,1-DCA, 1,1-DCE, acetone, benzene, chloroform, methylene chloride, TCE, and xylene. Other periodic detections included Freon 113, MEK, carbon disulfide, and MTBE.

Phase II RFI

The Phase II RFI for this SWMU had not yet been conducted at the time of the other Phase II RFI activities conducted during 1993 program. As previously discussed, it was recommended that any Phase II RFI activities be conducted in order to coordinate

with closure activities planned for SWMU 142 and implementation of an Interim Corrective Measures Plan for SWMU 154.

Phase III RFI

Five borings (HLSF-SB-013, HLSF-SB-014, HLSF-SB-016, HLSF-SB-017, and HLSF-SB-018), were advanced to a depth of 50 ft bgs in addition to those proposed at SWMU 154 surrounding the HCF. The samples were analyzed for phosphorus, hexavalent chromium, total chromium, lead, sodium, zinc, ethylene glycol, alcohols, VOCs, SVOCs, TPH-GRO, VOC-DRO, and TOC.

Groundwater samples were collected from Monitoring Wells CFW-01, CFW-02, CFW-03, and CFW-04. Due to the proximity of wells to the HELSTF Systemic Diesel Spill (SWMU 154), groundwater samples were also analyzed for SVOCs and TPH-DRO.

A new downgradient monitoring well (HMW-62) was installed to determine if regional groundwater has been impacted. Additional groundwater samples were to be collected from ten nearby existing monitoring wells (DRW-01, DRW-02, DRW-05, DRW-06, DRW-15, HCF-01, HCF-04, HCF-06, HMW-13, and HMW-52).

Groundwater samples were analyzed for water quality parameters, dissolved ions, phosphorous, hexavalent chromium, total chromium, sodium, zinc, alcohols, VOCs, TPH GRO, and TOC. Due to the proximity of the wells to the Chromiumate Spill Site (SWMU 143), Former MAR Waste Stabilization Pond (SWMU 148), and Systemic Diesel Spill (SWMU 154), groundwater samples were also analyzed for ammonia-nitrogen, dissolved ions, cadmium, copper, lead, silver, SVOCs, and TPH-DRO.

6.12.5 Nature and Extent of Contamination

In order to delineate the extent of soils affected by the HELSTF Cleaning Facility Sump, numerous soil boring locations surrounding SWMU 142 were evaluated. The soil boring locations are shown on Figure 6.12-1, and a comprehensive soil analytical data table is provided in Table 6-112 ~~10 of Appendix D-2~~.

6.12.5.1 ~~*Shallow Soil (0 to 10 ft bgs) VOCs*~~Of the ten sample locations and 31 soil samples ~~*evaluated for shallow soil (• 10 ft bgs), the analytes detected above the laboratory reporting limits were arsenic, barium, cadmium, chromium, lead, selenium, organic carbon, BEHP, TPH, 1,1-DCA, 1,1,1-TCA, and xylenes. Table 6.12-1 provides a statistical summary of data for shallow soil and Table 6.12-2 provides a summary of exceedances of regulatory standards for shallow soil at SWMU 142.*~~

6.12.5.1.1 Shallow Soil (0 to 10 ft bgs) ~~VOCs~~

No VOC detections exceeded the NMED SSLs for residential soils in shallow soils ~~(• 10 ft bgs)~~ at this unit. ~~1,1-DCA, 1,1,1-TCA and total xylene were the only VOC detections in shallow soils at SWMU 142. The 1,1-DCA detection was observed in a surface sample from South Bore No. 2 (1.40 mg/kg), the xylene detection was observed at 9 feet in Boring CFW-04 (0.0086 mg/kg), and 1,1,1-TCA was observed in South Bore No. 2 at the surface (1.2 mg/kg), 1 foot (.055 mg/kg), and 10 feet (0.070 mg/kg).~~ The only VOC that was detected above the DAF 1 was one detection of 1,1-DCA at South Bore No. 2. ~~was the only constituent exceeding its NMED DAF 1 screening level of 0.339 mg/kg.~~ This 1,1-DCA exceedance of the DAF 1 screening value was an isolated occurrence and it has been delineated laterally and vertically (deeper samples from South Bore No. 2 did not have detectable concentrations of 1,1-DCA). The 1,1-DCA occurrences in soil at and in the vicinity of SWMU 142 are shown on Figure 6.12-2, and its isolated occurrence in shallow soil at this unit is also shown on Figure G-4 in Appendix ~~Figure~~ G ~~in Appendix G~~. ~~Xylene is not a COPC associated with this SWMU. The presence of xylene at 9 ft bgs is related to the underlying impacts from the Systemic Diesel Spill (SWMU 154).~~

6.12.5.1.2 Deep Soil (Greater than 10 ft bgs)

The VOCs 1,1,1-TCA, 1,1-DCA, 1,1-DCE, acetone, benzene, carbon tetrachloride, methylene chloride, ethylbenzene, isopropylbenzene, and xylenes were detected in deep soil above the DAF 1 criteria. Benzene, ~~ethyl benzene~~ethylbenzene, isopropylbenzene, and xylenes are attributable to the release from SWMU 154 and are not COPCs associated with SWMU 142. Methylene chloride is a common laboratory artifact and this detection is most likely associated with laboratory contamination. In addition, the detection of methylene chloride is limited to only one sample. Therefore, methylene chloride is not considered a COPC associated with SWMU 142.

Seventeen detections of 1,1-DCA exceeded the NMED DAF 1 screening level at the following locations: 142B1 (19 ft bgs), 142B2 (19 ft bgs), 142B3 (19, 23, 25, 35 and 39

ft bgs), 147B1 (15 ft bgs but was not replicated in the duplicate sample, 25 ft bgs), CFW-01 (33, 37 and 39 ft bgs), CFW-02 (23-25 ft bgs), CFW-03 (18-20 ft bgs), East Bore #3 (25 ft bgs), South Bore #2 (0 ft), West Bore #1 (20 ft bgs). The DAF 1 exceedances for 1,1-DCA have been delineated at all of these locations with the exception of 142B3, where no soil samples were ~~detected~~ collected deeper than 39 ft bgs. The occurrences of 1,1-DCA in soil at SWMU 142 are shown on Figure 6.12-2. As shown Figure G-5 in Appendix~~on Figure G in Appendix G~~, the distribution of 1,1-DCA in deep soil is concentrated around the cleaning facility building and, therefore, has generally been delineated laterally in that area. Vadose zone water in the SWMU 142 area has been impacted by 1,1-DCA at concentrations exceeding the NMED Groundwater Standard (Table 6-22~~1~~). However, no 1,1-DCA has been detected in downgradient regional groundwater in wells DRW-15, HMW-55, and HMW-64 (Table 6-23~~YY~~).

Detections of 1,1,1-TCA exceeding the NMED DAF 1 screening value were limited to the North Bore No. 4 (16, 20, and 25 ft bgs), East Bore No. 3 (15 ft bgs), and South Bore No. 2 (15 ft bgs). There are no 1,1,1-TCA exceedances in deeper soils at any of these three locations or in surrounding borings, indicating vertical and lateral delineation. There were no exceedances of 1,1,1-TCA in adjacent vadose zone wells (approximate depth to water 45 ft bgs). The occurrences of 1,1,1-TCA in soil at and in the vicinity of SWMU 142 are shown on Figure 6.12-2. The general lateral delineation of 1,1,1-TCA in deep soil is shown on Figure G-6 in Appendix G~~-6~~.

Seventeen detections of 1,1-DCA exceeded the NMED DAF 1 screening level at the following locations: 142B1 (19 ft bgs), 142B2 (19 ft bgs), 142B3 (19, 23, 25, 35 and 39 ft bgs), 147B1 (15 ft bgs but was not replicated in the ~~duplicate~~parent sample, 25 ft bgs), CFW-01 (33, 37 and 39 ft bgs), CFW-02 (23-25 ft bgs), CFW-03 (18-20 ft bgs), East Bore #3 (25 ft bgs), South Bore #2 (0 ft), West Bore #1 (20 ft bgs). The DAF 1 exceedances for 1,1-DCA have been delineated at all of these locations with the exception of 142B3, where no soil samples were detected deeper than 39 ft bgs. The occurrences of 1,1-DCA in soil at SWMU 142 are shown on Figure 6.12-2. As shown on Figure G-5 in Appendix G~~-5on Figure G XX in Appendix G~~, the distribution of 1,1-DCA in deep soil is concentrated around the cleaning facility building and, therefore, has generally been delineated laterally in that area. Vadose zone water in the SWMU 142 area has been impacted by 1,1-DCA at concentrations exceeding the NMED Groundwater Standard (Table 6-21~~2~~). However, no 1,1-DCA has been detected in downgradient regional groundwater in wells DRW-15, HMW-55, and HMW-64 (Table 6-23~~2~~).

Only one detection of acetone at 25 ft bgs at boring location 142B3 exceeded the DAF 1 criterion. No acetone was detected in deeper samples (29, 35, and 39 ft bgs) at this location. Thus, the acetone occurrence at 142B3 has been delineated vertically. Occurrences of acetone in soils at and in the vicinity of SWMU 142 are shown on Figure 6.12-2. No acetone exceedances were observed in surrounding vadose zone wells (approximate depth to water 45 ft bgs). The general lateral delineation of acetone in deep soils at and near the Cleaning Facility is shown on Figure G-7 in Appendix G ~~-7on Figure G-7 in Appendix G~~. This figure indicates that the acetone exceedance of the DAF 1 in deep soil at 142B3 is isolated and has been delineated laterally.

One detection of carbon tetrachloride (3.90 mg/kg) was observed at East Bore No. 3 at a depth of 20 ft bgs. The detection exceeds the NMED DAF 1 screening value (Figure 6.12-2). However, no detected carbon tetrachloride exceedances were observed at the 25 ft bgs or 30 ft bgs depths in East Bore No. 3, indicating vertical delineation. Surrounding sample locations were also non- detect for carbon tetrachloride, indicating lateral delineation. Carbon tetrachloride was not detected in surrounding vadose zone or Regional Aquifer wells. The occurrence of carbon tetrachloride deep soils at SWMU 142 is depicted on Figure 6.12-2, and the general lateral delineation of carbon tetrachloride exceedances in deep soil at the HELSTF is shown on Figure G-8 in Appendix G ~~-8on Figure G-8 in Appendix G~~.

6.12.5.2 *SVOCs*

6.12.5.2.1 Shallow Soil (0 to 10 ft bgs)

No SVOC detections exceeded the NMED SSL or DAF 1 screening levels in shallow soils ~~(• 10 ft bgs)~~ at this unit.

6.12.5.2.2 Deep Soil (Greater than 10 ft bgs)

The only SVOCs that were detected in deep soil above the DAF 1 screening criteria were naphthalene and N-Nitrosodiphenylamine. Naphthalene is a COPC associated with the underlying impacts from the release from SWMU 154 and its occurrence is not attributable to a release from SWMU 142. As shown in Table 6-1~~6.1-1~~, N-Nitrosodiphenylamine is a pesticide and is not associated with wastes at the HELSTF. Therefore, N-Nitrosodiphenylamine is not considered a COPC for SWMU 142.~~BEHP was the only SVOC detection in shallow soils at SWMU 142. The BEHP detection was observed at 5 feet in Boring 147B1 (0.46 mg/kg), which does not exceed~~

~~the NMED SSL (347 mg/kg) or DAF 1 (1,070 mg/kg) screening levels. Phthalates are common laboratory artifacts. This detection of BEHP is likely related to laboratory contamination. BEHP is not a COPC associated with the Cleaning Facility Sump (SWMU 142).~~

6.12.5.3 *Other Parameters*

6.12.5.3.1 Shallow Soil (0 to 10 ft bgs)

Elevated concentrations (>100 mg/kg) of TPH were detected in shallow soils at CFW-04 and HCF-01. ~~Concentrations of TPH were detected in one of three shallow soil samples and TPH (C10-C28) were detected in five of the 10 soil samples designated for these analyses.~~ TPH are not COPCs associated with SWMU 142. TPH occurrences in soil are attributable to underlying impacts from the Systemic Diesel Spill (SWMU 154)~~, as discussed in Section 6.21 (page 38).~~

6.12.5.3.2 Deep Soil (Greater than 10 ft bgs)

Elevated concentrations (>100 mg/kg) of TPH were detected in deep soils beneath and surrounding SWMU 142. As stated above, TPH are not COPCs associated with SWMU 142 but are attributable to the underlying impacts from the release from SWMU 154.

6.12.5.4 *Metals*

6.12.5.4.1 Shallow Soil (0 to 10 ft bgs)

Arsenic was the only metal detected above the SSL in shallow soil at SWMU 142. Arsenic, barium, cadmium, ~~chromium, lead,~~ and selenium were detected above their respective DAF 1 criteria in shallow soils ~~(• 10 ft bgs)~~ at SWMU 142. As discussed in Section 4.3.6 (page 44), detections of arsenic, barium, and selenium do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained these constituents. The detections of barium and selenium are being attributed to naturally occurring conditions that were identified in the literature review. The arsenic~~, barium, and selenium~~ detections are attributable to ~~naturally occurring~~ redox-related conditions existing at the HELSTF and, therefore, ~~is~~are not considered COPCs associated with SWMU 142. However, the arsenic reported in shallow zone soil from ~~East Bore #3 at this location~~ was detected at concentrations that exceed those levels considered as naturally

occurring ~~background~~. Wastes containing arsenic were not managed at this SWMU. This isolated occurrence of elevated arsenic in shallow soil at ~~this~~ SWMU 142 appears to be attributable to redox conditions created when the sump and/or lines associated with the sump were leaking and resulted in wetted soils beneath the floor of the Cleaning Facility. It should be noted that arsenic has not been detected above the regulatory limits in vadose zone water from nearby wells (CFW-01, HCF-01, and CFW-04) (Table 6-22) and also has not been detected in downgradient Regional Aquifer groundwater from HMW-54 and HMW-55 (Table 6-23).

~~Chromium was detected in 14 of the 24 shallow soil samples and lead was detected in 15 of the 24 shallow samples designated for these analyses. Chromium detections were observed at five sampling locations: CFW-04, East Bore No. 3, North Bore No. 4, South Bore No. 2, and West Bore No. 1. Lead detections were observed at five sampling locations: CFW-04, East Bore No. 3, North Bore No. 4, South Bore No. 2, and West Bore No. 1. None of the chromium detections or lead detections exceeded their respective NMED SSLs for residential soils. There are no DAF 1 screening values for chromium and lead.~~

~~Cadmium was detected in 12 of the 24 shallow soil samples designated for this analysis. None of the cadmium detections exceeded the NMED SSL for residential soil (39 mg/kg).~~ Cadmium detections exceeded the NMED DAF 1 screening value of 1.37 mg/kg at four sampling locations. However, none of the detections exceeded the background screening level of 5.81 mg/kg (Table F-5 of Appendix F) and, therefore, none of the cadmium detections are considered exceedances of a regulatory standard. ~~General delineation of cadmium in shallow soils at the HELSTF is shown on Figure G-5 in Appendix G.~~

6.12.5.4.2 Deep Soil (Greater than 10 ft bgs)

Arsenic, barium, cadmium, hexavalent chromium, and selenium were detected above their respective DAF 1 criteria in deep soil at SWMU 142. Arsenic detections are~~, barium, and selenium are~~ attributable to redox-related conditions in the HELSTF and are not indicative of a release from SWMU 142. The detections of barium and selenium are being attributed to naturally occurring conditions that were identified in the literature review.

Detections of cadmium exceeding the NMED DAF 1 screening value of 1.37 mg/kg was observed at the following locations: HCF-01 (19 to 20 ft bgs), North Bore No. 4 (16 and 20 ft bgs), South Bore No. 2 (15 ft bgs), and West Bore No. 1 (11 and

25.5 ft bgs). The maximum detection of cadmium was 2.00 mg/kg, detected at HCF-01 (19 to 20 ft bgs), North Bore No. 4 (16 and 20 ft bgs), and at West Bore No. 1 (11 ft bgs). The cadmium exceedances of the DAF 1 have been delineated vertically at each location and they have been delineated laterally in the area. The occurrences of cadmium in soil are depicted on Figure 6.12-3. General delineation of cadmium in deep soils at the HELSTF is shown on Figure G-9 in Appendix G ~~-9on Figure G-9 in Appendix G.~~

Hexavalent chromium was detected in 7 of the 62 deep soil samples designated for this analysis. Detections of hexavalent chromium that exceeded the DAF 1 in deep soils at SWMU 142 occurred at one location, CFW-02 at 43 to 45, 48 to 50, 53 to 55, and 58 to 60 ft bgs. The depth to water in CFW-02 is approximately 45.5 to 46 ft bgs. Thus, the hexavalent chromium exceedances in deep soil here are most likely associated with saturated soils and may be more indicative of vadose zone water conditions than soil conditions, especially because hexavalent chromium was not detected in shallow soils at this location. The occurrences of hexavalent chromium at SWMU 142 are shown on Figure 6.12-3 and the general lateral distribution of hexavalent chromium in deep soils at the HELSTF is shown on Figure G-10 in Appendix G.~~-10on Figure G-10 in Appendix G.~~

6.12.5.5 ~~*Shallow Soil*~~ *Summary*

There were no VOCs, SVOCs, or metals (with the exception of arsenic, which is attributable to redox conditions at the HELSTF) detected above the NMED SSLs for residential soil in shallow soils at SWMU 142. ~~In summary\, t~~The only COPC that was detected above the DAF 1 screening value ~~a regulatory standard~~ in shallow soils at SWMU 142 was 1,1-DCA. This VOC was also detected in deep soils at SWMU 142 above the DAF 1 screening criterion. With one exception (142B3), the 1,1-DCA exceedances of the DAF 1 standard have been delineated vertically. The DAF 1 exceedances in soil have also been delineated laterally in this area. Vadose zone water in the vicinity of the Cleaning Facility Sump has been impacted by 1,1-DCA above the NMED Groundwater Standard. However, 1,1-DCA has not been detected in downgradient regional groundwater wells. ~~The detected concentration did not exceed the SSL, but did exceed the DAF 1 screening value. This exceedance occurred in only one sample and has been delineated vertically and laterally. Figure 6.12-2 depicts the 1,1-DCA occurrence in shallow soil at SWMU 142.~~ In addition to 1,1-DCA, the VOCs 1,1,1-TCA, carbon tetrachloride, and acetone were identified as COPCs that had one or more detections in deep soils at SWMU 142 at concentrations exceeding the DAF 1 screening criteria.

The metals cadmium and hexavalent chromium were detected above their respective DAF 1 screening criteria in deep soils at SWMU 142 and are considered COPCs associated with this SWMU. Arsenic is related to redox conditions at the HELSTF. However, ~~T~~the arsenic reported in shallow zone soil at ~~this location~~ East Bore #3 was detected at concentrations that exceed those levels also being attributed to ~~considered~~ as naturally occurring redox affected concentrations.~~background.~~ Wastes containing arsenic were not managed at this SWMU. This isolated occurrence of elevated arsenic at this SWMU appears to be attributable to redox conditions created when the sump and/or associated lines leaked and wetted shallow soils beneath the floor of the Cleaning Facility.

~~6.12.5.6~~ *Depths to water measurements in the area of SWMU 142 (made at CFW-01, CFW-02, CFW-03, and CFW-04 in 2009) are approximately 43 ft bgs. VOCs and metals were detected at depths extending to 45 ft bgs. Therefore, it is assumed that the exceedances of VOCs and metals from approximately 45 ft bgs and deeper are associated with affected vadose zone water and not reflective of affected deep soils. Chromium and chlorinated solvents have been detected in vadose zone water and downgradient water from SWMU 142. SWMU 142 is known to have contributed to the vadose zone and regional groundwater impacts in this area. Vadose zone water and regional groundwater impacts are discussed in Section 6.25 (page 351) of this document.* ~~*Deep Soil (Greater than 10 ft bgs)*~~

~~6.12.5.6.1 Nineteen soil sample locations were evaluated for soils greater than 10 ft bgs. There were 19 VOC detections, 16 SVOC detections, and 13 metal detections. TPH, nitrite/nitrate, organic carbon, sulfide, and phosphorus were also detected Table 6.12-3 provides a statistical summary of data for deep soil and Table 6.12-4 provides a summary of exceedances of regulatory standards for deep soil at SWMU 142. Table 10 of Appendix D-2 provides a comprehensive summary of all SWMU 142 soil results. VOCs~~

~~The 19 VOC detections included the following parameters: 1,1,1-TCA, 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113), 1,1-DCA, 1,1-DCE, acetone, benzene, carbon disulfide, carbon tetrachloride, ethylbenzene, isopropylbenzene, m,p-xylene, methylene chloride, naphthalene, n-butylbenzene, n-propylbenzene, o-xylene, sec-butylbenzene, toluene, and total xylenes. Of these, benzene, ethylbenzene, isopropylbenzene, m,p-xylene naphthalene, n-butylbenzene, n-propylbenzene, o-xylene, sec-butylbenzene, toluene, and total xylenes are not considered COPCs associated with wastes or releases at SWMU 142. As discussed in Section 6.21 (page 38), these constituents are associated with the underlying impacts from the Systemic Diesel Spill (SWMU 154) and they are addressed as COPCs for SWMU 154.~~

1,1,1-TCA was detected in 26 of the 116 deep soil samples designated for this analysis in the vicinity of SWMU 142. Detections of 1,1,1-TCA exceeding the NMED DAF 1 screening value of 1.33 mg/kg are limited to the North Bore No. 4 (16, 20, 25, and 30 ft bgs), East Bore No. 3 (15 ft bgs), and South Bore No. 2 (15 ft bgs). Detections below regulatory levels were observed at 142B2, 142B3, CFW-01, CFW-02, CFW-03, and West Bore No. 1. There are no 1,1,1-TCA exceedances in deeper soils at East Bore No. 1 or South Bore No. 2 or in surrounding borings, indicating vertical and lateral delineation. The North Bore No. 4 exceedances were observed to 30 ft bgs, with no sampling at greater depths at this location. The occurrences of 1,1,1-TCA in soil at and in the vicinity of SWMU 142 are shown on Figure 6.12-2. The maximum 1,1,1-TCA detection was 21 mg/kg, at South Bore No. 2. However, there were no exceedances of 1,1,1-TCA in adjacent vadose zone wells (approximate depth to water 45 ft bgs). The general lateral delineation of 1,1,1-TCA in deep soil is shown on Figure G-3 in Appendix G.

No Freon 113 detection exceeded the NMED DAF 1 screening level in deep soil. The Freon 113 detection was observed at 15 feet in South Bore No. 2 (12.5 mg/kg), which does not exceed the DAF 1 (168 mg/kg) screening level.No 1,1 DCA detection exceeded the NMED the NMED DAF 1 (0.339 mg/kg) screening level. The maximum 1,1-DCA detection was 0.095 mg/kg at boring location 142B3 at a depth of 19 ft bgs.

1,1-DCE was identified in two deep soil samples, both of which did not exceed the NMED DAF 1 (0.134 mg/kg) screening level. The maximum 1,1-DCE detection was 0.048 mg/kg at CFW-03 at a depth of 18 ft bgs to 20 ft bgs.

Detections of acetone exceeding the NMED DAF 1 screening value of 0.955 mg/kg were observed at the following locations: 142B1 (19 and 37 ft bgs), 142B2 (19 ft bgs), and 142B3 (23, 25, and 39 ft bgs). Additional acetone detections were observed at 142B2, 142B3, 147B1, and CFW-02, but concentrations were below the DAF 1 screening level. The maximum detection of acetone was 6.10 mg/kg at boring location 142B3 at a depth of 25 ft bgs. There are no acetone exceedances in soils beneath the 142B2 exceedance or in surrounding borings, indicating vertical and lateral delineation. The 142B1 and 142B3 deepest exceedances were observed between 37 and 39 ft bgs, with no sampling at greater depths. Occurrences of acetone in soils at and in the vicinity of SWMU 142 are shown on Figure 6.12-2. However, no acetone exceedances were observed in surrounding vadose zone wells (approximate depth to water 45 ft bgs). The general lateral delineation of acetone in deep soils at and near the Cleaning Facility is shown on Figure G-4 in Appendix G.

~~Carbon disulfide was detected in 1 of the 98 deep soil samples designated for this analysis at a concentration of 0.0065 mg/kg, which is below the NMED SSL for residential soil and the DAF 1 screening value. This is an isolated occurrence of carbon disulfide, which has been delineated vertically and horizontally. Carbon disulfide was a common laboratory artifact and its detection is likely due to laboratory contamination. In addition, carbon disulfide was detected in only one sample at SWMU 142. Therefore, carbon disulfide is not considered a COPC associated with SWMU 142.One detection of carbon tetrachloride (3.90 mg/kg) was observed at East Bore No. 3 at a depth of 20 ft bgs. The detection exceeds the NMED DAF 1 screening value of 0.000974 mg/kg (Figure 6.12-2). However, no detected carbon tetrachloride exceedances were observed at the 25 ft bgs or 30 ft bgs depths in East Bore No. 3, indicating vertical delineation. Surrounding sample locations were also non-detect, indicating lateral delineation. Carbon tetrachloride was not detected in surrounding vadose zone or Regional Aquifer wells. The occurrence of carbon tetrachloride in soils at SWMU 142 is depicted on Figure 6.12-2.~~

> ~~6.12.5.6.2 No detection of methylene chloride exceeds the NMED SSL for residential soil (182 mg/kg). There was a single detection of methylene chloride, 0.020 mg/kg, detected at CFW-03 at a depth of 18 to 20 ft bgs. Because there are no exceedances at greater depths or in surrounding borings, this location is considered vertically and laterally delineated. The detection exceeds the NMED DAF 1 screening value of 0.00851 mg/kg. Methylene chloride is a common laboratory artifact and this detection is most likely associated with laboratory contamination. In addition, the detection of methylene chloride is limited to only one sample. Therefore, methylene chloride is not considered a COPC associated with SWMU 142.SVOCs~~

~~The following 16 SVOCs were detected in deeps soils in the vicinity of SWMU 142: 1,2,4-TMB, 1,3,5-TMB, 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, anthracene, benzoic acid, BEHP, dibenzofuran, diphenylamine, fluoranthene, fluorene, N-nitrosodiphenylamine, phenanthrene, p-isopropyltoluene, and pyrene. Of these, 1,2,4-TMB, 1,3,5-TMB, 1-naphthalene, 2-naphthalene, acenaphthene, anthracene, dibenzofuran, fluoranthene, fluorene, phenanthrene, p-isopropyltoluene, and pyrene are not considered COPCs associated with SWMU 142. As discussed in Section 6.21 (page 38), these constituents are associated with the underlying impacts from the Systemic Diesel Spill (SWMU 154) and are addressed as COPCs for SWMU 154.As shown in Table 6.1-1, diphenylamine and n-nitrosodiphenylamine are pesticides and are not associated with wastes at the HELSTF. Therefore, these constituents are not considered COPCs for SWMU 142.~~

Benzoic acid was detected in only 1 of the 70 deep soil samples designated for this analysis, at a concentration of 0.41 mg/kg at HLSF-SB-013 (20-21 ft bgs), which was below the NMED DAF 1 screening criterion. Benzoic acid is not a known COPC associated with SWMU 142.

6.12.5.6.3 BEHP was detected in 2 of the 72 deep soil samples designated for this analysis, at concentrations below the NMED DAF 1 screening criterion. BEHP is a common laboratory artifact, and these detections are likely attributable to laboratory contamination. In addition, these detections are isolated two deep soil samples collected in the vicinity of SWMU 142. Therefore, BEHP is not considered a COPC for SWMU 142.Other Parameters

Total cyanide was detected in 4 of the 16 deep soil samples designated for this analysis at concentrations ranging from 0.2 to 0.53 mg/kg. There are no regulatory standards for cyanide in soil. Cyanide is not a known COPC associated with SWMU 142.

6.12.5.6.4 TPH were detected in 19 of 22 deep soil samples analyzed. In addition, TPH-GRO were detected in 15 of 31 samples, TPH-DRO were detected in 15 of 31 samples and TPH (C18-C28) were detected in 35 of 50 samples at SWMU 142. TPH are not COPCs associated with SWMU 142. They are associated with underlying impacts from the Systemic Diesel Spill (SWMU 154), as described in Section 6.21 (page 38).Metals

The following 13 metals were detected in deep soils in the vicinity of SWMU 142: arsenic, barium, cadmium, chromium, copper, hexavalent chromium, lead, nickel, potassium, selenium, sodium, vanadium, and zinc. As discussed in Section 4.3.6 (page 38), detections of arsenic, barium, selenium, and vanadium do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained these constituents. The arsenic, barium, and selenium detections, in addition to sodium and potassium, are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 142. None of the detections of chromium, copper, lead, nickel, or zinc in deep soils at SWMU 142 exceeded their respective DAF 1 screening values.

The arsenic reported in deep zone soil at this location was detected at concentrations that exceed those levels considered as background. This isolated occurrence of elevated arsenic at this SWMU may be due to redox conditions created when the sump and/or associated lines leaked and wetted soils beneath the Cleaning Facility floor.

Detections of cadmium exceeding the NMED DAF 1 screening value of 1.37 mg/kg was observed at the following locations: HCF-01 (19 to 20 ft bgs), North Bore No. 4 (16 and 20 ft bgs), South Bore No. 2 (15 ft bgs), and West Bore No. 1 (11 and 25.5 ft bgs). Additional cadmium detections were observed at CFW-03, CFW-04, East Bore No. 3, HCF-01, HLSF-SB-017, North Bore No. 4, South Bore No. 2, and West Bore No. 1, but concentrations were below DAF 1 screening levels. The maximum detection of cadmium was 2.00 mg/kg, detected at HCF-01 (19 to 20 ft bgs), North Bore No. 4 (16 and 20 ft bgs), and at West Bore No. 1 (11 ft bgs). The cadmium exceedances of the DAF 1 have been delineated vertically at each location and they have been delineated laterally in the area. The occurrences of cadmium in soil are depicted on Figure 6.12-3. General delineation of cadmium in deep soils at the HELSTF is shown on Figure G-6 in Appendix G.

6.12.5.6.5 Hexavalent chromium was detected in 7 of the 62 deep soil samples designated for this analysis. Detections of hexavalent chromium that exceeded the DAF 1 in deep soils at SWMU 142 occurred at one location, CFW-02 at 43 to 45, 48 to 50, 53 to 55, and 58 to 60 ft bgs. Hexavalent chromium was also detected at 16, 18, and 24 ft bgs at CFW-04, at concentrations below the DAF 1 screening value. The depth to water in CFW-02 is approximately 45.5 to 46 ft bgs. Thus, the hexavalent chromium exceedances in deep soil here are most likely associated with saturated soils and may be more indicative of vadose zone water conditions than soil conditions, especially because hexavalent chromium was not detected in shallow soils at this location. The occurrences of hexavalent chromium at SWMU 142 are shown on Figure 6.12-3. Deep Soil Summary

In summary, the only COPCs detected in soils at SWMU 142 are acetone, 1,1-DCA, carbon tetrachloride, 1,1,1-TCA, cadmium, and hexavalent chromium. The DAF 1 exceedances for 1,1-DCA and carbon tetrachloride were limited to only one shallow sample each. The hexavalent chromium exceedances all occurred in apparent saturated soil at one location and are most likely representative of vadose zone water conditions rather than soil conditions. All of the exceedances of the DAF 1 in soil have been delineated for SWMU 142.

Depths to water measurements in the area of SWMU 142 (made at CFW-01, CFW-02, CFW-03, and CFW-04 in 2009) are approximately 43 ft bgs. VOCs and metals were detected at depths extending to 45 ft bgs. Therefore, it is assumed that the exceedances of VOCs and metals from approximately 45 ft bgs and deeper are associated with affected vadose zone water and not reflective of affected deep soils. Chromium and chlorinated solvents have been detected in vadose zone water and downgradient water from SWMU 142. SWMU 142 is known to have contributed to the vadose zone and regional groundwater impacts in this area. Vadose zone water and

~~regional groundwater impacts are discussed in Section 6.25 (page 38) of this document.~~

~~The arsenic reported in deep zone soil at this location was detected at concentrations that exceed those levels considered as background. This isolated occurrence of elevated arsenic at this SWMU may be attributable to redox conditions created when the sump and/or associated piping leaked and wetted the soil beneath the Cleaning Facility floor. It should be noted that arsenic has not been detected above the regulatory limits in vadose zone water from nearby wells (CFW-01, HCF-01, and CFW-04) and also has not been detected in downgradient Regional Aquifer groundwater from HMW-54 and HMW-55.~~

6.12.6 Human Health Risk Assessment Findings

~~6.12.6.1~~ Data collected during site characterization activities during the RFIs were used in the evaluation of risk to human health. A description of risk assessment methodologies and results is provided~~on page 134 of~~ on page 144 of Appendix E.~~Soil Exposure Scenarios~~

~~Surface Soil (0 to 2 ft bgs)~~

~~In accordance with NMED guidance (NMED, 2006a), constituent concentrations in surface soil were compared to health-based screening levels for future industrial worker exposure and residential exposure, and the calculated ratios summed. The results of this data screening process indicate that after comparison to health-based SSLs, the total ratios for carcinogenic effects were greater than the NMED target ratio of 1. Four COPCs were selected for surface soil under the future industrial and residential scenarios.~~

~~The total ELCR value for the direct contact exposure pathway for the future site worker scenario is within the target risk range of 10^{-6} to 10^{-4} for carcinogenic effects. The total HI value for the direct contact exposure pathway for the future site worker scenario is below the benchmark of 1 for non-cancer hazard, indicating adverse non-carcinogenic effects are unlikely to occur.~~

~~The total ELCR value for the direct contact exposure pathway for a hypothetical future resident is greater than the acceptable target risk range of 10^{-6} to 10^{-4} for carcinogenic effects. The total HI value for the direct contact exposure pathway for a hypothetical future resident is above the benchmark of 1 for non-cancer hazard. When the HI for a hypothetical future resident exposure to surface soil is segregated by target organ site~~

and critical effects, the HI for skin is above the benchmark of 1. The primary risk driver for the elevated HI was arsenic. As described in Section 6.12.5.1.2 (page 38), arsenic is a naturally occurring metal that has resulted in low redox conditions beneath the Cleaning Facility.

Combined Surface and Subsurface Soil (0 to 10 ft bgs)

6.12.6.2 *In accordance with NMED guidance (NMED, 2006a), constituent concentrations in combined surface and subsurface soil (0 to 10 ft bgs) were compared to health-based screening levels and the calculated ratios summed. The total ratios were less than the NMED target ratio of 1. The results of this data screening process indicate that after comparison to health-based SSLs for construction worker exposure, no COPCs were selected for combined surface and subsurface soil at SWMU 142. This demonstrates that the constituent concentrations in combined surface and subsurface soil at SWMU 142 are unlikely to result in adverse health impacts to the future construction workers via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, dermal).Vapor Intrusion Scenarios*

Total Soil (Vadose Zone)

All detected volatile constituents in total soil (i.e., vadose zone) were selected as COPCs for the future vapor intrusion evaluation because there are no NMED or USEPA SSLs that are protective of the vapor intrusion pathway.

The total ELCR values for the vapor intrusion exposure pathway for the future site worker and hypothetical future resident are above the target risk range of 10^{-6} to 10^{-4} for cancer effects. The total HI values for the vapor intrusion exposure pathway for the future site worker and future residential are above the benchmark of 1. When the HI for a future site worker exposure to indoor air is segregated by target organ site and critical effects, none of the hazards are above the benchmark of 1. The primary risk driver for the ELCR was carbon tetrachloride, which was detected in 1 of 116 samples at a depth of 20 ft bgs.Saturated Vadose Zone Water

All detected volatile constituents in saturated vadose zone water were compared to the USEPA (2002a) groundwater screening levels for vapor intrusion, and the calculated ratios summed. The total ratios were below the NMED target ratio of 1. The results of this data screening process indicate that after comparison to health-based soil screening levels for protection of vapor intrusion, no COPCs were selected for saturated vadose zone water at SWMU 142. This demonstrates that the constituent

~~concentrations in saturated vadose zone water are unlikely to result in adverse health impacts to future site workers and future residents potentially exposed via vapor intrusion to indoor air.~~

~~6.12.6.3 *Overall HHRA Summary*~~

Based on the results of the HHRA, the following conclusions can be made:

- The calculated ELCR and HI are within or below acceptable target risk ranges for future site workers exposed to surface soil via direct contact (incidental ingestion, inhalation of vapor/dust, and dermal contact).

The results of the HHRA indicate that under hypothetical future conditions at the site, the following exposure scenarios resulted in calculated ELCRs and/or HIs that exceeded the acceptable target risk benchmarks:

- Future site worker exposed, via vapor intrusion, to indoor air containing VOCs originating from total soil (i.e., vadose zone);
- Future resident exposed to surface soil via direct contact (incidental ingestion, inhalation of vapor/dust, and dermal contact); and
- Future resident exposed, via vapor intrusion, to indoor air containing VOCs originating from total soil (i.e., vadose zone).

There are no unacceptable risks and/or hazards to current receptors (i.e., site workers) at SWMU 142. The unacceptable risks and hazards were calculated for extremely unlikely future scenarios using highly conservative exposure assumptions. Therefore, the potential for COPCs at SWMU 142 to represent a significant concern in the future is considered low, and additional evaluation is considered unnecessary.

It is important to reiterate that the scenarios for which unacceptable risks and/or hazards were calculated are all hypothetical future scenarios. There are no unacceptable risks and/or hazards to current receptors (i.e., site workers) at SWMU 142.

6.12.7 Ecological Risk Assessment Findings

As described within the ERA presented on page 147 of Appendix E, a SLERA and BERA were completed for SWMU 142. After the SLERA, two constituents (i.e., arsenic and selenium) were selected as COPECs in surface soil and three constituents [BEHP; arsenic; and selenium] were selected as COPECs in combined surface and subsurface soil because their HQs were greater than 1. In the BERA, arsenic and selenium in surface soil and in combined surface and subsurface soil were retained for further evaluation in the food chain modeling because they were identified as bioaccumulative.

Tables E.9.ERA-20 and E.9.ERA-21 of Appendix E summarize the COPECs in surface soil and in combined surface and subsurface soil, respectively, that were carried through the BERA and evaluated in the terrestrial food chain model. As shown in these tables, all receptors evaluated in the terrestrial food chain refined scenarios had LOAEL and NOAEL HQs less than or equal to 1 for arsenic. The refined scenario LOAEL and NOAEL HQs for the mourning dove, red-tailed hawk, and desert kit fox exposed to surface soil were less than or equal to 1 for selenium, while the Merriam's kangaroo rat, the desert shrew, and the cactus wren had refined HQs slightly above 1. Considering the LOAEL HQs (a more realistic indicator of toxicity) for the Merriam's kangaroo rat and the cactus wren are less than or equal to 1 and the LOAEL HQ for the desert shrew is only slightly above 1, and that the spatial extent of affected soil is extremely small, the potential is low for future adverse ecological effects.

Comment [KG3]: Page number needed?

It is important to reiterate here that the above assessment is for a hypothetical future scenario and only applies if the site was redeveloped and the HCF building removed. Thus, there are no current ecological risks at SWMU 142.

6.12.8 Conclusions and Recommendations

In summary, the exceedances of regulatory standards in soils at SWMU 142 have been delineated. The sump was reconfigured and some impacted soil was removed when the release was discovered. It should be noted that operations at the Cleaning Facility ceased in April 2009. Thus, there is no ongoing source of contamination at SWMU 142.

There were no VOCs, SVOCs, or metals (with the exception of arsenic, which is attributable to redox conditions at the HELSTF) detected above the NMED SSLs for residential soil in shallow soils at SWMU 142. The only COPC that was detected above the DAF 1 screening value in shallow soils at SWMU 142 was 1,1-DCA. The

VOCs 1,1-DCA, 1,1,1-TCA, carbon tetrachloride, and acetone , and the metals cadmium and hexavalent chromium were detected above their respective DAF 1 screening criteria in deep soils at SWMU 142 and are considered COPCs associated with this SWMU.

The isolated occurrence of elevated arsenic in the shallow zone at East Bore #3 appears to be attributable to redox conditions created when the sump and/or associated lines leaked and wetted shallow soils beneath the floor of the Cleaning Facility. Arsenic-containing wastes were not managed at SWMU 142. Arsenic has not been detected above the regulatory limits in vadose zone water from nearby wells (CFW-01, HCF-01, and CFW-04) nor in downgradient Regional Aquifer groundwater from HMW-54 and HMW-55.

Chromium and chlorinated solvents have been detected in vadose zone water and downgradient water from SWMU 142. SWMU 142 is known to have contributed to the vadose zone and regional groundwater impacts in this area.

The HHRA for SWMU 142 indicates that current industrial use of the site would result in potential exposures that are within or below the regulatory benchmarks for cancer risks and non-cancer hazards.

The evaluation also indicates that potential future industrial use or residential use of the site may result in potential exposures to surface soil and indoor air that are above the regulatory benchmarks for cancer risks and non-cancer hazards. However, the primary risk drivers in this evaluation were arsenic in soil and carbon tetrachloride in indoor air. Wastes containing arsenic were not managed at SWMU 142. Arsenic is a naturally occurring metal ~~that has~~ that solubilized as a result ~~ed in~~ of redox conditions created by wetted soils beneath the Cleaning Facility. In addition, it is important to note that carbon tetrachloride was detected in only 1 of 116 samples. Given the low frequency of detection and the depth of the sample where carbon tetrachloride was detected (20 ft bgs), this is an extremely conservative evaluation of potential risks.

~~It should be noted that arsenic has not been detected above the regulatory limits in vadose zone water from nearby wells (CFW-01, HCF-01, and CFW-04) and also not detected in downgradient Regional Aquifer groundwater from HMW-54 and HMW-55. SWMU 142 will be further addressed as part of a long-term groundwater monitoring program. In addition, it is important to note that carbon tetrachloride was detected in 1 of 116 samples. Given the low frequency of detection and the depth of the sample where carbon tetrachloride was detected, this is an extremely conservative evaluation~~

~~of potential risks (20 ft bgs).~~A SLERA and a BERA were completed for SWMU 142 to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents detected in surface soil and subsurface soil. The results indicate that under current conditions adverse effects are not expected for wildlife that may access the site.

Potential future industrial and residential use of the site may result in potential surface soil and indoor air exposures that are above the regulatory benchmarks for cancer and non-cancer hazards if all exposure assumptions are met. It is important to reiterate that the scenarios for which unacceptable risks and/or hazards were calculated are all hypothetical future scenarios. There are no unacceptable risks and/or hazards to current human receptors (i.e., site workers) at SWMU 142 or to wildlife that may access the site.

Soil investigations have been completed at SWMU 142. The vadose zone water and regional groundwater in the vicinity of SWMU 142 will be monitored as part of a HELSTF-wide long term groundwater monitoring program.~~Wastes containing arsenic were not managed at SWMU 142. Arsenic is a naturally occurring metal that has resulted in redox conditions beneath the Cleaning Facility. It should be noted that arsenic has not been detected above the regulatory limits in vadose zone water from nearby wells (CFW-01, HCF-01, and CFW-04) and also not detected in downgradient Regional Aquifer groundwater from HMW-54 and HMW-55. SWMU 142 will be further addressed as part of a long-term groundwater monitoring program.~~

6.13 SWMU 143 – HELSTF Storage Yard Chromi~~ate~~um Spill Site (WSMR-54)

6.13.1 Unit Description

The HELSTF Storage Yard Chromi~~ate~~um Spill Site (SWMU 143) is located in an unpaved area in the northeastern corner of the paved HELSTF Equipment Storage Yard (SWMU 141).~~, which consists of a 1.2-acre, flat-lying, fenced yard that was paved in 1990~~ The Chromi~~ate~~um Spill Site is inactive, and was initially covered by a shingled, wooden roof to inhibit leaching and runoff of chromate resulting from a spill of Entec 300, a corrosion inhibitor containing hexavalent chromium. The cover was removed during 1998 in order to conduct a gaseous reduction test using injection and extraction wells. A plastic sheet barrier was installed below the subsurface to inhibit leaching and runoff of chromate associated with the spill.

6.13.2 Operational History

A release of approximately 55 gallons of Entec 300, a corrosion inhibitor containing hexavalent chromium and zinc, resulted from the mishandling of the raw material. The release was discovered in December 1989 while the area was being prepared for paving. The principal COPC associated with this SWMU is chromium.

6.13.3 Regulatory History

The Cchromiumate sSpill Site was not identified during the RFA process. Therefore, the site was not included in the initial 1989 RCRA permit. This SWMU is listed on the current facility RCRA permit as a SWMU requiring corrective action.

As previously discussed, the spill area was identified in December 1989 during site preparation activities conducted prior to paving the area. The first soil sample was collected from the area on January 10, 1990, and was found to have chromium present at 1,210 mg/kg. In response to the discovery, a site investigation was conducted by the USAEHA in July 1990. Eighteen soil samples were selected from randomly selected locations throughout the Equipment Storage Yard to determine if chromates had been released at other locations in the yard. As a result of the investigation, it was determined that chromium spills had not occurred at other locations in the yard, and it was determined that the release occurred sometime between 1982 and 1983 during handling of a 55-gallon drum of Entec 300, a corrosion inhibitor containing hexavalent chromium and zinc.

Concurrent with the investigation, approximately 17 drums of chromium-contaminated soil were reportedly excavated to a depth of 8 ft and removed from the site. The removal was reportedly suspended when it was determined that all of the visibly contaminated soil could not be removed. The excavation was backfilled with clean soil and the surrounding area was paved when it was determined that the release was isolated to the northeast corner of the Equipment Storage Yard. The area that was impacted was not paved, but was covered with a shingled roof to minimize infiltration due to precipitation (USAEHA, 1990).

On August 7, 1991, the site was added to the list of Appendix IV sites of the 1989 RCRA Permit as SWMU 143 for SWMUs requiring an RFI. As further described in Section 6.13.4 (Investigative History, page 218), the Phase I RFI was conducted during 1991. When the roof was removed for drilling rig access during the Phase I RFI, visually contaminated soils were observed in the spill site area. Based upon the results

of the investigation, it was determined that impacts to soil and groundwater had occurred and that additional assessment as part of a Phase II RFI was warranted.

As further described in Section 6.13.4 (Investigative History, page 218), a Phase II RFI was conducted at this SWMU, and soil and groundwater samples were collected from this location to characterize site conditions. Based upon the results of the assessment VOCs, SVOCs, and seven metals were detected in soil samples and groundwater samples from this SWMU. Detections of some of the VOCs and SVOCs could not be attributed to SWMU 143 because substances containing these constituents were never managed at this location. The detections in the vicinity of HMW-36 were attributed to releases associated with the nearby HELSTF Systemic Diesel Spill area (SWMU 154), and the others were attributed to an unknown source~~, but could have been~~.

Total and dissolved chromium and hexavalent chromium were detected in groundwater samples during the Phase II RFI. Due to these conditions, it was recommended that a CMS be conducted to address chromium contamination at SWMU 143. Periodic groundwater monitoring began in accordance with the Work Plan in February 1995 (ESE, 1995); the NMED provided comments on the Work Plan on March 13, 1995 (Morgan, 1995).

On May 23, 1996, the USEPA issued an NOD for the Phase II report, citing that the four chromium-contaminated wells in the vadose zone may be hydraulically connected with the Regional Aquifer and, therefore, a CMS should be initiated to remove chromium from the shallow water zone and interim measures should be taken to abate the release of the newly discovered organics (Honker, 1996). On September 4, 1996, the NMED issued an NOD for the Phase II RFI report. As part of the NOD, it was requested that WSMR perform a risk assessment as part of a Phase III RFI to fully evaluate threats to human health and the environment at SWMUs with impacts (including SWMU 143) (Kelly, 1996).

An In Situ Gas Treatment Technology Demonstration Test Plan (Thorton and Miller, 1996) was prepared and submitted to the NMED by Sandia National Laboratories (SNL) in February 1996. The plan consisted of an SNL Innovative Technology Demonstration Project (ITDP) to provide for the testing and evaluation of a gas treatment system using dilute concentrations of hydrogen sulfide injected into the subsurface to convert hexavalent chromium to a less toxic trivalent form. The conceptual plan included a test that would consist of an injection well (IGRS-1) surrounded by six extraction wells as well as soil-gas monitoring points, all screened from 3 to 8 ft bgs, within a well field of approximately 30 feet in diameter.

In September 1996, WSMR decided to implement the demonstration project under a Voluntary Corrective Measures (VCM) phased approach. Pilot scale testing of the In Situ Gaseous Reduction demonstration project involved a series of tests, including a soil gas test (December 17, 1997), a gas-treatment injection test (76 days from April to June 1998), and an air permeability test (August 22-23, 1998). Soil samples were collected following the injection test to evaluate the performance of the technology. The final report of the In Situ Gaseous Reduction Pilot Demonstration was completed in February 1999. An additional report entitled *Presumptive Remedy for HELSTF Chromium Spill Site SWMU 143* (WSMR 1999), was issued in March 1999. The technology was successful and reportedly reduced 70 percent of the hexavalent chromium to trivalent chromium in the upper 10 feet of soils. NMED concurred with the success of the remedy and technology and considered the remedy complete for hexavalent chromium (Lewis, 1999).

As further described under Section 6.13.4 (Investigative History, page 218), a Phase III RFI was conducted. The purpose of the investigation was to delineate the chromium and zinc contamination and included collection of soil samples, installation of one additional monitoring well, and collection of groundwater samples.

6.13.4 Investigative History

The soil sampling locations ~~A summary of monitoring points~~ used to ~~investigate~~ evaluate SWMU 143 are shown on Figure 6.13-1 and a comprehensive data summary is provided in Table 6-123~~is provided in Table 11 of Appendix D-2~~. Descriptions of assessments are provided below.

USAEHA Investigation

The USAEHA investigation was conducted during July 1990. As a result of the investigation, impacted soil was excavated and the spill area was covered with a shingled roof to minimize infiltration of water from the ground surface.

Phase I RFI for Appendix IV Sites

The Phase I RFI included collection of a background soil sample (143BG1), collection of eight soil samples from three borings (143B1, 143B2, and 143B3) at depths ranging from 10 ft bgs to 30 ft bgs, and collection of groundwater from a nearby vadose zone monitoring well (HMW-11) installed for the SWMU 148 RFI (Former Mar Waste

Stabilization Pond). Soil samples were analyzed for metals. The groundwater sample was analyzed for VOCs, SVOCs, metals, TPH, and hexavalent chromium.

Background results for 143BG1 indicated a detection of total chromium at 0.031 mg/kg. There were no metals detected in nearby background Sample 148BG1, and arsenic was detected in the other nearby background soil sample, 141BG1, at 0.54 mg/kg. the Phase I RFI report indicated that ~~S~~soil sample results for SWMU 143 ~~indicated~~ included detections of background levels of arsenic and barium, and chromium concentrations (up to 14 mg/kg) above background. Groundwater data collected from Monitoring Well HMW-11 detected concentrations of hexavalent chromium, total chromium, 1,1-DCE, and TCE at levels that exceeded the 1992 federal and state MCLs and state groundwater protection levels. Selenium was also detected at concentrations exceeding action levels; however, these concentrations were comparable to detections site-wide and were attributed to the natural occurrence of selenium at the site. The groundwater from HMW-11 was reported to have a greenish-yellow tint.

Based upon the results, it was determined that a significant release had occurred at SWMU 143. It was believed the contaminant source was effectively removed based on soil sample data. The extent of the release was not known and additional investigation as part of a Phase II RFI was recommended.

Phase II RFI

As part of the Phase II RFI, a total of 37 soil samples were collected from borings for nine newly installed monitoring wells (HMW-36 through HMW-43 and HMW-47) and six 10-foot soil borings (0143SB01 through 0143SB06). Soil samples from the monitoring well borings were analyzed for VOCs, SVOCs, TPH, and metals. Soil samples from the 10-foot soil borings were analyzed for total and hexavalent chromium only. A total of 15 groundwater samples were collected during the Phase II RFI for SWMU 143 from Monitoring Wells HMW-02, HMW-09, HMW-10, HMW-11, HMW-13, HMW-17, HMW-36 through HMW-43, and HMW-47. HMW-42 and HMW-47 are screened in the Regional Aquifer and the remaining 13 wells are screened in the vadose zone. Groundwater samples were analyzed for VOCs, SVOCs, TPH, metals (dissolved and total), hexavalent chromium, and TDS.

The soil sample from 18 ft bgs at HMW-36 had detected concentrations of acetone, 2-methylnaphthalene, and phenanthrene. Soil from 59 ft bgs in HMW-43 had detected concentrations of TCE below its proposed Subpart S action level. No other VOCs or

SVOCs were detected in the soil samples. With the exception of cadmium, all of the metals analyzed were detected in soil at SWMU 143; however, none of the detected soil metal constituents approached their respective 1993-1994 regulatory levels.

Nine VOCs were detected in the groundwater samples. Two of the nine constituents were detected below their respective 1993-1994 action levels, ethylbenzene and total xylenes. Chloroform, 1,1-DCA, TCE, 1,1-DCE, 1,1,1-TCA, carbon tetrachloride, and benzene were all detected above their respective action levels. Groundwater data also indicated that metal constituents were greater than their 1993-1994 respective action levels at all monitoring wells except HMW-9 and HMW-36. Detected metal constituents included selenium, cadmium, and hexavalent chromium. Selenium was detected above its action level in 13 of the 15 monitoring wells, cadmium was detected in one monitoring well above its action level, and hexavalent chromium was detected above its action level in 4 of the 15 groundwater samples from SWMU 143. With the exception of HMW-13, HMW-17, and HMW-36, TDS levels exceeded the NMED's aquifer protection standard of 10,000 mg/L.

Based upon the results of the Phase II RFI, it was concluded that the detections of VOCs and SVOCs in soil and groundwater at HMW-36 were attributable to conditions resulting from releases at HELSTF Systemic Diesel Spill Area (SWMU 154). Total, dissolved, and hexavalent chromium were detected above the Federal and State MCLs and the State groundwater protection standards in Vadose Zone Wells HMW-11, HMW-38, HMW-39, and HMW-41. Chromium was detected above its action level in groundwater from Regional Well HMW-16 and hexavalent chromium was detected above its action level in groundwater from Regional Well HMW-47. No chromium was detected in groundwater from Regional Well HMW-42. Based on the results of soil analyses during the Phase I and II RFIs, it was evident that the source of chromium had been effectively removed from SWMU 143. The source of VOCs detected in vadose zone water and regional groundwater was determined to be uncertain, but possibly related to the release from the cleaning facility.

The Phase II RFI report also recommended that a CMS be conducted for the identified chromium contamination in vadose zone water and regional groundwater, if the regulatory agencies confirmed that the contamination posed a threat to human health and the environment and, therefore, warranted a CMS.

Monitoring Wells HMW-42 and HMW-47, installed during the Phase II RFI, were plugged and abandoned during May 1999 (WTS, 2006).

In-Situ Gas Treatment Technology Demonstration Test Plan

A pilot version of the gas treatment plan that included an in-situ gaseous reduction (ISGR) demonstration was initiated during December 1997. ~~that included an in-situ gaseous reduction (ISGR) demonstration.~~ This ~~study included a~~ demonstration us~~ed~~ing a series of tests that included a gas test (conducted during December 1997), a gas-treatment injection test (conducted between April 14, 1998, through June 1998), and an air permeability test (August 22 and 23, 1998). Soil samples were collected following the injection test to assess the performance of the technology.

Data collected during the pilot study showed up to a 70 percent reduction of hexavalent chromium to trivalent chromium for subsurface conditions in the upper 30 feet of soils. The majority of soils treated were 5 to 10 ft bgs (Thorton et al., 1999). The final report of the ISGR Pilot Demonstration was completed in February 1999.

Phase III RFI

Five borings (HLSF-SB-022, HLSF-SB-023, HLSF-SB-024, HLSF-SB-026, and HLSF-SB-028) were installed to a depth of 50 ft bgs to define the horizontal extent of chromium and zinc contamination. Soil samples were analyzed for hexavalent chromium, total chromium, and zinc. Due to the proximity of the site to the Former MAR Waste Stabilization Pond (SWMU 148), the soil borings were also analyzed for nitrate-nitrite as N, phosphorous, cadmium, copper, silver, sodium, alcohols, VOCs, and TOC.

A groundwater monitoring well (HMW-53) was installed in the vadose zone water to further delineate the extent of chromium to the east of SWMU 143. Groundwater samples were analyzed for water quality parameters, ammonia-nitrogen, dissolved ions, cadmium, chromium, copper, lead, phosphorus, silver, sodium, zinc, VOCs, SVOCs, ethylene glycol, TPH, and TOC. This well was installed to characterize vadose zone groundwater conditions in the vicinity of the Former MAR Waste Stabilization Pond (SWMU 148) and the HELSTF Systemic Diesel Spill (SWMU 154), as well as for the ~~Chromate~~HELSTF Storage Yard Chromium Spill Area (SWMU 143).

No VOCs or SVOCs were detected in soil from the newly installed soil borings. The only metals detected in soil from these borings were arsenic and barium and . ~~O~~only arsenic was detected above regulatory standards. Chloride, fluoride, and sulfate were the only constituents detected above their respective regulatory standards in vadose zone water from HMW-53.

6.13.5 Nature and Extent of Contamination

The soil boring locations are shown on Figure 6.13-1, and a comprehensive data summary for soil is provided in Table 6-123.1 ~~of Appendix D-2. Table 6.13-1 provides a statistical summary of data for shallow soil and Table 6.13-2 provides a summary of exceedances of regulatory standards for shallow soil at SWMU 143~~

Soil sample locations inside SWMU 143 boundaries, SWMU 148 boundaries, SWMU 141 boundaries, and well locations north, east, and southeast of SWMU 143 were used to evaluate the nature and extent of the contamination at SWMU 143. The only COPCs associated with this unit ~~is~~are , hexavalent chromium, and zinc. Thus, the discussion of nature and extent of impacts in soil is limited to ~~chromium~~these COPCs.

6.13.5.1 ~~*Shallow Soil (0 to 10 ft bgs)*~~*VOCs* ~~*In the 33 shallow soil samples collected, seven metals (arsenic, barium, chromium, hexavalent chromium, lead, mercury, and silver) were detected above laboratory reporting limits.*~~

6.13.5.1.1 Shallow Soil (0 to 10 ft bgs)~~VOCs~~

There were no VOCs detected in shallow soil ~~(• 10 ft bgs)~~ at SWMU 143.

6.13.5.1.2 Deep Soil (Greater than 10 ft bgs)

TCE was detected in only 1 of the 46 deep soil samples designated for this analysis, HMW-43 (59 ft bgs), at a concentration of 0.0403 mg/kg), which exceeds the NMED DAF 1 screening value of 0.0053 mg/kg. This exceedance of the NMED DAF 1 is isolated to this location and has been delineated laterally. Because TCE was not detected in shallow soils at HMW-43, the TCE exceedance of the DAF 1 standard at 59 ft bgs is not the result of a release from an overlying source area. The depth to the water in HMW-43 is approximately 43 ft bgs. Thus, the exceedance of TCE occurs in saturated soil. The TCE exceedance has been delineated vertically within the soil column at HMW-43. It should be noted that TCE has not been detected in vadose zone water from HMW-43. The occurrence of TCE in deep soil at this location is not indicative of a release from SWMU 143 because TCE is not a COPC for SWMU 143.

6.13.5.2 *SVOCs*

6.13.5.2.1 Shallow Soil (0 to 10 ft bgs)

There were no SVOCs detected in shallow soil ~~(• 10 ft bgs)~~ at SWMU 143.

6.13.5.2.2 Deep Soil (Greater than 10 ft bgs)

There were no SVOCs detected in deep soil at concentrations exceeding the DAF 1 screening criteria.

6.13.5.3 *Metals*

6.13.5.3.1 Shallow Soil (0 to 10 ft bgs)

With the exception of arsenic, which is attributable to redox-related conditions at the HELSTF, there were no metals detected at concentrations exceeding the NMED SSLs for residential soil in shallow soils at SWMU 143.

Mercury was detected above the DAF 1 screening criterion of 0.0293 mg/kg in shallow soils at HMW-43 (9 ft bgs) and SWMU 148 SB-07 (1 ft bgs). These mercury occurrences above the DAF1 are isolated and delineated. Mercury is not a COPC associated with the Chromium Spill Site.

~~Arsenic, barium, chromium, hexavalent chromium, lead, mercury, and silver were detected in shallow soils at SWMU 143. As discussed in Section 4.3.6 (page 38), detections of arsenic and barium do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained these constituents. The arsenic and barium detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 143.Chromium was detected in 2 of 27 samples, lead was detected in 5 of the 15 samples, and mercury was detected in 3 of the 15 samples designated for these analyses. None of these metals were detected in shallow soil at SWMU 143 above their respective NMED SSLs, and mercury was not detected above its DAF 1 screening value. There are no DAF 1 screening values for chromium and lead.Hexavalent chromium was detected in 5 of the 30 shallow soil samples designated for this analysis.~~ Hexavalent chromium was detected at concentrations exceeding the NMED DAF 1 standard (2.11 mg/kg) at 143B1 (5.3 mg/kg at 5 ft bgs) and 143B3 (14 mg/kg at 10 ft bgs). The concentration of hexavalent

chromium that exceeded the DAF 1 at 143B1 (5 ft bgs) has been delineated vertically and laterally. The DAF 1 exceedance for hexavalent chromium at 143B3 (10 ft bgs) has been delineated laterally and vertically, as indicated by the results for adjacent Boring 143SB03, which reported no detections of hexavalent chromium at 0 ft bgs, 4 ft bgs, and 9 ft bgs. No hexavalent chromium detection in shallow soil exceeded the NMED SSL for residential soil (234 mg/kg). The hexavalent chromium exceedances of the DAF 1 standard at and in the vicinity of SWMU 143 are shown on Figure 6.13-2, and . Ggeneral lateral delineation of hexavalent chromium in shallow soils at the HELSTF is shown on Figure G-11 in Appendix G. -11on Figure G-711 in Appendix G.

~~Silver was detected in 5 of the 15 shallow soil samples designated for this analysis.~~ Silver was detected at HMW-43 (1, 3, and 9 ft bgs) and at SWMU 148 SB-03 (4 and 8 ft bgs) at concentrations exceeding the NMED DAF 1 screening value ~~of 1.57 mg/kg~~. The concentrations of silver exceeding the DAF 1 standard in soil from HMW-43 appear to be isolated to this location, and the extent of these impacts has been delineated vertically to a depth of 38 ft bgs there. ~~These exceedances have also been delineated laterally (i.e., there are no exceedances of the DAF 1 standard for silver in shallow soil from nearby soil borings). The concentrations of silver exceeding the DAF 1 standard at SWMU 148 SB-03 (4 and 8 ft bgs) also appear to be isolated and have been delineated laterally. Deeper soils at nearby soil borings do not indicate the presence of silver above the DAF 1 standards and are, therefore, indicative of vertical delineation of these impacts. No silver detection in shallow soil exceeded the NMED SSL residential soil value of 391 mg/kg. The maximum silver detection was 74.8 mg/kg at a depth of 8 ft bgs at SWMU 148 SB-03.~~ Silver is not a COPC for SWMU 143.

6.13.5.3.2 Deep Soil (Greater than 10 ft bgs)

Arsenic was detected above the DAF 1 screening criterion in 26 deep soil samples, barium was detected above the DAF 1 screening value in 1 deep soil sample, and selenium was detected above the DAF 1 screening value in 2 deep soil samples in the vicinity of SWMU 143. Detections of arsenic, barium, and selenium do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained these constituents. The arsenic~~, barium, and selenium~~ detections are attributable to redox-related conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 143. The detections of barium and selenium are being attributed to naturally occurring conditions that were identified in the literature review.

Mercury was detected above the DAF 1 criterion at 48 ft bgs at HMW-41, and silver was detected above its NMED DAF 1 screening value at the following locations: HMW-36 (18 ft bgs), HMW-39 (19 ft bgs), and HMW-43 (18 and 38 ft bgs) (Figure 6.13-2). Neither mercury nor silver are considered COPCs associated with the Chromium Spill Site.

Hexavalent chromium, an identified COPC associated with SWMU 143, was not detected above the DAF 1 standard in deep soils. General delineation of hexavalent chromium in deep soils at the HELSTF is shown on Figure G-10 in Appendix G. ~~-10 on Figure G-10 in Appendix G.~~

6.13.5.4 ~~*Shallow Soil*~~ *Summary*

In summary, no COPCs were detected in shallow soil in the vicinity of SWMU 143 above the NMED SSLs for residential soils. ~~h~~Hexavalent chromium is the only COPC identified for SWMU 143 that was detected above ~~a regulatory standard~~the DAF 1 screening criterion. These DAF 1 exceedances occurred at only two locations and they have been delineated vertically and horizontally. ~~in shallow soil (• 10 ft bgs). Silver was also detected in five samples from two locations at concentrations exceeding the DAF 1 standard. No hexavalent chromium or silver detections exceeded the SSL for residential soil. The DAF 1 exceedances of hexavalent~~

~~6.13.5.4.1~~ Depth to water measurements made in 2009 at groundwater monitoring wells screened within the vadose zone water (HMW-11, HMW-41, and HMW-43) indicate that water levels are at approximately 40 ft bgs. Hexavalent chromium has been detected at concentrations above the NMED Tapwater standard in vadose zone water from nearby Wells HMW-11, HMW-39, and HMW-41 and has been detected in downgradient regional groundwater from DRW-14. Chromium has been detected above the NMED groundwater standard in vadose zone water from DRW-09, DRW-10, HMW-11, HMW-39, and HMW-41 and in downgradient regional groundwater from DRW-14 and HMW-42. Based on the soil sampling results, the source area for chromium, hexavalent chromium, and zinc was effectively removed. However, the historical release resulted in impacts to vadose zone and regional groundwater in the vicinity of SWMU 143.~~chromium and silver in the upper 10 feet of soil have been delineated.~~VOCs~~

~~Acetone was detected at only one location (HMW 36, 18 ft bgs) at a concentration below the NMED DAF 1 screening value. Acetone is a common laboratory artifact and this detection is likely attributable to laboratory contamination. Additionally, it should be noted that the detection is isolated to only one sample collected at this SWMU.~~

Therefore, the detection of acetone is not attributed to soil conditions at SWMU 143, and it is not considered a COPC associated with this SWMU.

TCE was detected in only 1 of the 46 deep soil samples designated for this analysis, HMW-43 (59 ft bgs), at a concentration of 0.0403 mg/kg), which exceeds the NMED DAF 1 screening value of 0.0001 mg/kg. This exceedance of the NMED DAF 1 is isolated to this location and has been delineated laterally. Because TCE was not detected in shallow soils at HMW-43, the TCE exceedance of the DAF 1 standard at 59 ft bgs is not the result of a release from an overlying source area. The depth to the water in HMW-43 is approximately 43 ft bgs. Thus, the exceedance of TCE occurs in saturated soil. Therefore, the TCE exceedance has been delineated vertically within the soil column at HMW-43. It should be noted that TCE has not been detected in vadose zone water from HMW-43. The occurrence of TCE in deep soil at this location is not indicative of a release from SWMU 143 because TCE is not a COPC for SWMU 143.

SVOCs

6.13.5.4.2 None of the three SVOCs detected in deep soil (>10 ft bgs) at SWMU 143 exceeded regulatory standards. 2-Methylnaphthalene was detected in 1 of the 41 deep soil samples and phenanthrene was detected in 1 of the 46 deep soil samples analyzed for these constituents. Di-n-octylphthalate was detected in 2 of the 47 deep soil samples designated for this analysis. The maximum detections of 2-methylnaphthalene (1.37 mg/kg) and phenanthrene (0.496 mg/kg) occurred at 18 ft bgs at HMW-36, approximately 80 feet north of SWMU 143. Di-n-octylphthalate was detected in 2 of the 47 deep soil samples designated for this analysis. The maximum detection of di-n-octylphthalate (0.594 mg/kg) occurred at HLSF-SB-023 (49-50 ft bgs). Phthalates are common laboratory artifacts and these two detections are likely attributable to laboratory contamination. Additionally, it should be noted that these detections are isolated to only two deep samples collected at this SWMU. None of the three detected SVOCs are COPCs for SWMU 143.Metals

Arsenic was detected in 26 of the 50 deep soil samples, barium was detected in 47 of 50 samples, and selenium was detected in 2 of 50 samples designated for these analyses. As discussed in Section 4.3.6 (page 38), detections of arsenic, barium, and selenium do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained these constituents. The arsenic, barium, and selenium detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 143.

The detection frequencies for the other metals in deep soil at SWMU 143 are as follows: hexavalent chromium was detected in 4 of the 33 deep soil samples, chromium was detected in 30 of 41 deep soil samples, lead was detected in 41 of 50 deep soil samples, mercury was detected in 1 of 50 deep soil samples, and zinc was detected in 25 of 25 deep soil samples that were designated for metal analyses. Hexavalent chromium, mercury, and zinc were detected below their respective DAF 1 screening values. There are no DAF 1 screening values for chromium and lead. Of these, only hexavalent chromium, chromium, and zinc are COPCs for SWMU 143. General delineation of hexavalent chromium in deep soils at the HELSTF is shown on Figure G-8 in Appendix G.

6.13.5.4.3 Deep Soil Summary

In summary, the COPCs associated with SWMU 143 are chromium, hexavalent chromium, and zinc. None of these constituents were detected above their respective NMED SSLs for residential soil in the upper 10 feet of soil. No zinc detections exceeded NMED DAF 1 standards. Only two hexavalent chromium detections (one at 143B1 [5 ft bgs] and one at 143B3 [10 ft bgs]) exceeded the DAF 1 standard. These exceedances have been delineated in soil vertically and laterally. Silver was also detected above its DAF 1 standard in soils at SWMU 143.

Depth to water measurements made in 2009 at groundwater monitoring wells screened within the vadose zone water (HMW-11, HMW-41, and HMW-43) register water levels at approximately 40 ft bgs. Hexavalent chromium has been detected at concentrations above the NMED Tapwater standard in vadose zone water from nearby Wells HMW-11, HMW-39, and HMW-41 and has been detected in downgradient regional groundwater from DRW-14. Chromium has been detected above the NMED groundwater standard in vadose zone water from DRW-09, DRW-10, HMW-11, HMW-39, and HMW-41 and in downgradient regional groundwater from DRW-14 and HMW-42. Based on the soil sampling results, the source area for chromium, hexavalent chromium, and zinc was effectively removed. However, the historical release resulted in impacts to vadose zone and regional groundwater in the vicinity of SWMU 143.

6.13.6 Human Health Risk Assessment Findings

Data collected during site characterization activities during the RFIs were used in the evaluation of risk to human health. A description of risk assessment methodologies and results is provided on page 162 ~~on page 134 of~~of ~~in~~ Appendix E.

6.13.6.1 *The HHRA for SWMU 143 indicates that current and future industrial use of the site would result in potential exposures that are within or below the regulatory benchmarks for cancer risks and non-cancer hazards. The evaluation also indicates that potential future residential redevelopment of the site would result in potential exposures that are within or below the regulatory benchmarks for cancer risks and non-cancer hazards. Based on these results, additional human health risk assessment is not warranted for SWMU 143.*~~*Soil Exposure Scenarios*~~

~~In accordance with NMED guidance (NMED, 2006a), constituent concentrations in surface soil were compared to health-based screening levels for future industrial worker exposure and residential exposure, and the calculated ratios summed. The results of this data screening process indicate that after comparison to health-based SSLs, the total ratios for carcinogenic effects were greater than the NMED target ratio of 1. Four COPCs were selected for surface soil under the future industrial and residential scenarios.~~

~~The total ELCR value for the direct contact exposure pathway for the future site worker scenario is within the target risk range of 10^{-6} to 10^{-4} for carcinogenic effects. The total HI value for the direct contact exposure pathway for the future site worker scenario is below the benchmark of 1 for non-cancer hazard, indicating adverse non-carcinogenic effects are unlikely to occur.~~

~~The total ELCR value for the direct contact exposure pathway for a hypothetical future resident is greater than the acceptable target risk range of 10^{-6} to 10^{-4} for carcinogenic effects. The total HI value for the direct contact exposure pathway for a hypothetical future resident is above the benchmark of 1 for non-cancer hazard. When the HI for a hypothetical future resident exposure to surface soil is segregated by target organ site and critical effects, the HI for skin is above the benchmark of 1. The primary risk driver for the elevated HI was arsenic. As described in Section 6.12.5.1.2 (page 38), arsenic is a naturally occurring metal that has resulted in low redox conditions beneath the Cleaning Facility.~~

Combined Surface and Subsurface Soil (0 to 10 ft bgs)

6.13.6.2 *In accordance with NMED guidance (NMED, 2006a), constituent concentrations in combined surface and subsurface soil (0 to 10 ft bgs) were compared to health-based screening levels and the calculated ratios summed. The total ratios were less than the NMED target ratio of 1. The results of this data screening process indicate that after comparison to health-based SSLs for construction worker exposure, no COPCs were selected for combined surface and subsurface soil at SWMU 142. This demonstrates that the constituent concentrations in combined surface and subsurface soil at SWMU 142 are unlikely to result in adverse health impacts to the future construction workers via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, dermal).Vapor Intrusion Scenarios*

Total Soil (Vadose Zone)

All detected volatile constituents in total soil (i.e., vadose zone) were selected as COPCs for the future vapor intrusion evaluation because there are no NMED or USEPA SSLs that are protective of the vapor intrusion pathway.

The total ELCR values for the vapor intrusion exposure pathway for the future site worker and hypothetical future resident are above the target risk range of 10^{-6} to 10^{-4} for cancer effects. The total HI values for the vapor intrusion exposure pathway for the future site worker and future residential are above the benchmark of 1. When the HI for a future site worker exposure to indoor air is segregated by target organ site and critical effects, none of the hazards are above the benchmark of 1. The primary risk driver for the ELCR was carbon tetrachloride, which was detected in 1 of 116 samples at a depth of 20 ft bgs.Saturated Vadose Zone Water

All detected volatile constituents in saturated vadose zone water were compared to the USEPA (2002a) groundwater screening levels for vapor intrusion, and the calculated ratios summed. The total ratios were below the NMED target ratio of 1. The results of this data screening process indicate that after comparison to health-based soil screening levels for protection of vapor intrusion, no COPCs were selected for saturated vadose zone water at SWMU 142. This demonstrates that the constituent concentrations in saturated vadose zone water are unlikely to result in adverse health impacts to future site workers and future residents potentially exposed via vapor intrusion to indoor air.Overall HHRA Summary

6.13.7 Ecological Risk Assessment Findings

As described~~within the ERA presented on page 153 of~~ page 165 of ~~in~~ Appendix E, a SLERA and BERA were completed for SWMU 143. After the SLERA, one constituent (i.e., silver) was selected as a COPEC in surface soil and in combined surface and subsurface soil because the HQs were greater than 1. In the BERA, silver was retained for further evaluation in the food chain modeling because it was identified as bioaccumulative.

Tables E.10.ERA-20 and E.10.ERA-21 of Appendix E summarize the constituents in surface soil and in combined surface and subsurface soil that were carried through the BERA and evaluated in the terrestrial food chain model. As shown in these tables, all receptors evaluated in the terrestrial food chain refined scenarios had LOAEL and NOAEL HQs less than or equal to 1 with the exception of the desert shrew, which had a refined NOAEL HQ slightly above 1 and LOAEL HQ less than 1. However, the affected area of silver with refined HQs greater than 1 for the desert shrew has a very limited spatial extent (approximately 0.3 acre). Based on the overall analysis of the ERA for SWMU 143, the results indicate that if exposure were to occur, then adverse effects are not expected for wildlife that may access the site.

Comment [KG4]: Page number reference needed?

It is important to reiterate here that the above assessment is for a hypothetical future scenario and only applies if the site was redeveloped and the red crushed rock covering removed. There are no ecologically significant current risks at SWMU 143 because the site is currently covered by crushed red rock, which acts to prevent exposure to the underlying soil.

6.13.8 Conclusions and Recommendations

The only COPCs associated with SWMU 143 ((~~Chromate~~HELSTF Storage Yard Chromium Spill Area) are chromium, hexavalent chromium, and zinc. Hexavalent chromium was the only one of these constituents detected in soil above the DAF 1, and there were only two detections that exceeded the standard. These hexavalent chromium exceedances of the DAF 1 standard have been adequately delineated. The results of the soils investigations conducted at SWMU 143 indicate that the source area has been effectively removed and that remaining soils do not represent an ongoing source of contamination. However, the historical release resulted in chromium and hexavalent chromium impacts to nearby vadose zone water and downgradient regional groundwater above the regulatory standards.

The vadose zone water and groundwater impacts will continue to be evaluated under a long-term monitoring program. The HHRA for SWMU 143 indicates that current and future industrial use of the site would result in potential exposures that are within or below the regulatory benchmarks for cancer risks and non-cancer hazards. The evaluation also indicates that potential future residential redevelopment of the site would result in potential exposures that are within or below the regulatory benchmarks for cancer risks and non-cancer hazards.

A SLERA and BERA were completed for SWMU 143 to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents detected in surface soil and subsurface soil, and to conduct food chain modeling for the COPEC identified as bioaccumulative (i.e., silver). The results of the SLERA and BERA for direct contact exposure and for food chain modeling indicate there is adequate information to conclude that there are no significant current exposures to soil, and future impacts are unlikely to occur for ecological receptors potentially exposed to constituents in soil. Therefore, no further ecological evaluation at SWMU 143 is warranted.

Based upon the results of the HHRA, SLERA, and BERA, no restrictions need to be applied to current or potential future land use at SWMU 143. SWMU 143 soils are recommended for closure.

6.14 SWMU 144 – Laser System Test Center (LSTC) Wastewater Discharge Pondint (CCWS-02; WSMR-47)

6.14.1 Unit Description

The LSTC Wastewater Discharge Pondint (also referred to as the Oryx Pit) is a rock-filled irregularly shaped pit surrounded by thick brush. The pit is approximately 10 feet in diameter by 8 feet deep. The pit was filled with rocks sometime during 1991 (ITC, 1992b).

6.14.2 Operational History

The LSTC Wastewater Discharge Pondint (SWMU 144) was used from the 1960s through circa 2008 for accepting discharge from the LSTC building (formerly the MAR Building, Building 26129). As part of the original construction, a sump and discharge pump were installed in the basement of Building 26129 to collect and eject chiller coil condensate water that was periodically drained from the building's fire

sprinkler system and blowdown from the cooling tower water treatment system (Hayslett, 1990b).

The water from this sump was pumped to a French drain located outside the HELSTF fence several hundred yards from the building. Because of the soil characteristics in the area of the French drain, the discharged water dissolved the gypsum-containing soil sufficiently to cause subsidence of the original drain. This subsidence resulted in fracturing of the drain pipe, and a cavity formed that created a hazard to personnel and wildlife. Two dead oryx were found in the pit in early 1990.

The constituents of concern for this SWMU consist mainly of chromium, detergents, solvents, and other constituents that may have been contained in the wastewater.

6.14.3 Regulatory History

The LSTC Wastewater Discharge Pondint was not identified in either of the two 1988 RFAs and, therefore, . Due to this condition, the site was not included in the 1989 RCRA Permit. The location came to the attention of the HELSTF personnel in early 1990 when two oryx were found dead in the cavity created by the discharge.

The USAEHA conducted an evaluation of environmental conditions at the HELSTF in July 1990. Based upon the results of the evaluation, the USAEHA reported that significant quantities of chromium-treated cooling water were discharged to this pond through the dischargeis line during the 1960s. Based upon this information, the unit was added to the RCRA Permit on August 7, 1991, as an Appendix IV site that required additional investigation. The LSTC Wastewater Discharge Pond is listed on the facility's current RCRA permit as SWMU 144, requiring corrective action.

As further described in Section 6.14.4 (Investigative History, page 233), assessment of the SWMU was conducted as part of the Phase I RFI in 1992. The Phase I RFI indicated detections of lead above background and regulatory levels in groundwater collected from the vadose zone water in HMW-07. It should be noted that HMW-07 was originally reported to be a Regional Aquifer well, but it has since been determined that it is screened in the vadose zone. Based upon this condition, the USEPA required that a Phase II RFI be conducted at this location.

A Phase II RFI was conducted and the assessment included collection of a sample of the wastewater discharge from the LSTC for analyses. The Phase II also included installation of four new monitoring wells, collection of soil samples, and collection of

groundwater samples from two existing monitoring wells, a nearby well used by the USGS, and two of the newly installed wells. As described in Section 6.14.4 (Investigative History, page 233), the RFI concluded that impacts to soil and groundwater were identified. The wastewater discharge contained TCE, but it was concluded that the discharge was not a continuing source of the constituents detected in the groundwater at this unit. Based upon this conclusion, WSMR proposed NFA for SWMU 144.

WSMR submitted NFA petitions for this unit in January 2000 and September 2001. The petitions were denied by NMED on March 11, 2002, because a final RFI report, including an ERA, was required. In addition, a background study to screen arsenic as a soil contaminant as well as to collect data supporting the contention that groundwater contamination was attributableed to another source was also required (Frischkorn, 2002).

6.14.4 Investigative History

The soil sampling locations ~~A summary of monitoring points~~ used to ~~investigate~~evaluate soil conditions at SWMU 144 are shown on Figure 6.14-1, and a comprehensive data summary is provided in Table 6-143.~~is provided in Table 12 of Appendix D-2.~~ Descriptions of previous assessments are provided below.

Phase I RFI

The Phase I assessment of SWMU 144 included installation of three monitoring wells to collect groundwater samples and soil samples. Monitoring wells installed during the Phase I RFI included two wells (HMW-07 and HMW-18B) screened in the vadose zone and one background well (HMW-08) screened in the Regional Aquifer. As stated previously, HMW-07 was first believed to be a Regional Aquifer well, but it has since been determined that this well is screened in the vadose zone water. Groundwater samples were analyzed for VOCs, SVOCs, TPH, and metals. Samples from HMW-07 and HMW-18B were also analyzed for hexavalent chromium.

Soil samples were collected for chemical analyses ~~at~~from the boring for Monitoring Well HMW-07 from 10, 15, 20, 25, 30, and 35 ft bgs and from three additional soil boring locations. The additional soil boring locations included: one 10-foot slant boring augered into the discharge pit (144B1, sample from 10 ft bgs); one shallow background boring (144BK1) augered outside the pit area; and one deep background boring (144BG1) augered to 45 ft bgs. Soil samples were collected at 10, 15, 20, 25, 30, 35,

40, and 45 ft bgs from the background boring. Soil samples were analyzed for VOCs, SVOCs, TPH, and metals.

Based upon the data collected during the Phase I RFI, it was concluded that no constituents were detected in the shallow background soil. Low levels of arsenic and barium were detected in the soil sample collected from the slant boring advanced into the discharge pit. Data collected for the soil samples from the 45-foot background boring indicated low concentrations of TPH at 20 and 25 ft bgs and detections of barium and lead at several depths. Soil data for HMW-07 indicated concentrations of arsenic, barium, and lead detected at concentrations that were reported to be representative of background, and low concentrations of TPH. Results of soil sampling are presented in Table 6-14~~312 of Appendix D-2~~.

No target constituents were detected in vadose zone water from HMW-18B. Vadose zone water from HMW-07 indicated detections of several metals (including hexavalent chromium) that were reported to be below background and/or 1992 regulatory limits. Concentrations of lead detected at HMW-07 exceeded reported background levels and 1992 regulatory levels. Groundwater data collected from the Regional Aquifer at b~~B~~ackground w~~W~~ell HMW-08 indicated concentrations of selenium detected below 1992 action levels. A summary of vadose zone water and groundwater data is provided in Section 6.25 (page 351) and Tables ~~1~~6-2~~2~~1~~X~~ and ~~2~~6-2~~3~~2~~Y~~, respectively~~, of Appendix D-3~~.

Based upon the results for groundwater collected at HMW-07, the USEPA required additional assessment as part of a Phase II RFI due to the detection of lead (Honker, 1993).

Phase II RFI

Assessment activities conducted during the Phase II RFI included installation of four new vadose zone monitoring wells (HMW-25, HMW-26, HMW-27, and HMW-28), collection of a sample of the wastewater discharge from the LSTC, collection of groundwater samples from existing and newly installed wells, and collection of three soil samples. At the time of the field program, groundwater samples could not be collected from Wells HMW-26 and HMW-27 because the wells did not provide sufficient quantities of water. Groundwater was also collected from existing Well HMW-07 and a nearby USGS monitoring well located 150 feet southwest of HMW-07. Soil samples were collected during the monitoring well installation program. One soil sample was collected from each of the borings for HMW-26 (39 ft bgs), HMW-27(18.5

ft bgs), and HMW-28 (38 ft bgs). All collected samples were analyzed for VOCs, SVOCs, TPH, and metals (including hexavalent chromium).

Data collected for the wastewater discharge from the LSTC indicated detections of two organic compounds (TCE and pyrene) at levels above the MCL but below NMED action levels. Dissolved arsenic and selenium and total lead were detected in the wastewater discharge. Dissolved selenium was the only metal detected in the wastewater discharge sample at concentrations above MCLs. The wastewater discharge was not analyzed for hexavalent chromium, but total and dissolved chromium were not detected.

Soil data indicated detections of various metals. Concentrations of barium and arsenic were detected above levels representative of background, based on the Phase I background levels. There were no concentrations of hexavalent chromium detected in soil samples. In addition, no VOCs or SVOCs were detected in the soil samples. A summary of soil sampling results is provided in Table 6-143 12 of Appendix D-2.

No SVOCs were detected in groundwater at this SWMU. No VOCs were detected in groundwater from existing Well HMW-07 or the USGS well. Groundwater data indicated detections, some exceeding the 1994 regulatory levels, of five VOCs in three of the five groundwater samples (HMW-18B, HMW-26, and HMW-28). These included 1,1-DCE, 1,1,1-TCA, carbon tetrachloride, and TCE detected at HMW-28, TCE at HMW-26, and 1,1,1-TCA at HMW-18B. Several metals were also detected at concentrations above 1994 regulatory levels in groundwater samples. The metals detected above regulatory levels included dissolved cadmium, total and dissolved selenium, total lead, and total, dissolved and hexavalent chromium. A summary of groundwater results is provided in Section 6.25 (page 351) and Tables 6-1212X and 26-223.Y of Appendix D-3).

Conclusions of the Phase II RFI stated that the wastewater discharge did not appear to be a continuing source of release to soil and groundwater at this unit. In addition, the report stated that there have been no significant releases of contaminants to soils surrounding the site. Metal detections in soil and groundwater were attributed to releases that occurred in the past. Chromium was the most significant metal detected. Detections of VOCs in groundwater were attributed to historical releases that may have originated from other areas at the HELSTF. Based upon these results, WSMR requested NFA for this SWMU in January 2000 and September 2001. The request was denied and additional assessment as part of a Phase III RFI was conducted to support a future NFA petition.

Phase III RFI

As part of the Phase III RFI, constituent concentrations in soil were compared to background levels (Appendix F) that were developed during the Phase III RFI (Appendix F). No additional soil samples were collected during the Phase III RFI.

Groundwater samples were proposed for collection from seven existing nearby monitoring wells (Regional Monitoring Well HELSTF-1 and Vadose Zone Monitoring Wells HMW-07, HMW-18B, HMW-25, HMW-26, HMW-27, and HMW-28). Groundwater sampling from regional monitoring Well HELSTF-1 was intended to determine if the Regional Aquifer had been impacted by previous discharges from the LSTC to SWMU 144. Groundwater samples were analyzed for water quality parameters, phosphorus, hexavalent chromium, chromium, sodium, zinc, VOCs, and TOC.

HMW-18B, HMW-25, HMW-27, and HMW-28 were all dry during the Phase III RFI sampling event. Groundwater collected from HMW-07 had concentrations of chromium and selenium that exceeded NMED groundwater standards, and concentrations of 1,1-DCE, chloroform, and TCE below NMED groundwater standards. Groundwater from HMW-26 contained selenium above the NMED groundwater standard and TCE at a concentration below the MCL. TCE was detected in groundwater from ~~the~~ Regional Well HELSTF-01 at a concentration of 35.1 µg/L (35.9 µg/L in the duplicate sample), which exceeds the MCL of 5 µg/L.

6.14.5 Nature and Extent of Contamination in Soil

In order to delineate the extent of soil impacts at the LSTC Wastewater Discharge Point (SWMU 144), seven soil boring locations that were advanced as part of all RFI-related activities were evaluated. The soil boring locations are shown on Figure 6.14-1, and a comprehensive data summary for soil is provided in Table 6-13~~412 of Appendix D-2~~.

6.14.5.1 ~~*Shallow Soil (0 to 10 ft bgs)*~~*VOCs*~~*Of the four samples collected from shallow soil (• 10 ft bgs), the only two analytes detected above their respective detection limits were acetone and arsenic. Table 6.14-1 provides a statistical summary of data for shallow soil and Table 6.14-2 provides a summary of exceedances of regulatory standards for shallow soil at SWMU 144.*~~

6.14.5.1.1 ~~VOCs~~Shallow Soil (0 to 10 ft bgs)

No VOCs were detected in shallow soils above NMED SSLs. Acetone was the only VOC detected in shallow soils at this unit, and it was detected in only one sample, HMW-07(10 feet), at 18.0 mg/kg, which is well below the NMED SSL for residential soil (~~28,100~~67,500 mg/kg) but exceeds the NMED DAF 1 screening level of 3.84 ~~0.955~~ mg/kg. The occurrence of acetone in soil at SWMU 144 is shown on Figure 6.14-2. The acetone exceedance of the DAF 1 is limited to soil at HMW-07 at SWMU 144 and has been delineated (i.e., the 10 ft sample from adjacent boring 144B1 was non-detect for acetone).~~The exceedance of the DAF 1 has been delineated.~~

6.14.5.1.2 Deep Soil (Greater than 10 ft bgs)

Acetone was the only VOC detected above the DAF 1 screening criterion in deep soils at SWMU 144. Acetone was detected above the DAF 1 at only one location, at 15 ft bgs in HMW-07, the same location where acetone exceeded the DAF 1 in shallow soil. The occurrences of acetone in soil at SWMU 144 are shown on Figure 6.14-2. The acetone exceedances of the DAF 1 are isolated to HMW-07 at SWMU 144 and have been delineated. General lateral delineation of acetone in deep soils at the HELSTF is shown on Figure G-7 in Appendix G.~~ 7on on Figure G-7 in Appendix G.~~

6.14.5.2 *SVOCs*

6.14.5.2.1 Shallow Soil (0 to 10 ft bgs)

No SVOCs were detected in shallow soils ~~(• 10 ft bgs)~~ at this unit.

6.14.5.2.2 Deep Soil (Greater than 10 ft bgs)

There were no SVOCs detected in deep soil at SWMU 144.

6.14.5.3 *Other Parameters*

6.14.5.3.1 Shallow Soil (0 to 10 ft bgs)

TPH (<100 mg/kg) were ~~-~~detected in only one ~~of the four~~ shallow soil sample (HMW-07 10 ft bgs) ~~s designated for this analysis. TPH were detected~~ at 80 mg/kg~~at HMW-07 (10 ft bgs)~~. TPH are not considered COPCs associated with waste management at SWMU 144. ~~Samples that were tested for TPH were also tested for full suites of VOCs and SVOCs that would comprise the TPH. The isolated VOC (acetone) is not a constituent associated with TPH.~~ No ~~other~~ VOCs typically associated with TPH were detected above comparative criteria.in shallow soils at SMWU 144, and ~~-N~~no SVOCs were detected in shallow soil samples. These conditions confirm that TPH is not a risk to potential receptors.

6.14.5.3.2 Deep Soil (Greater than 10 ft bgs)

Low concentrations of TPH (< 30 mg/kg) were detected in two of the nine deep soil samples (144B1 and 144BG1) designated for these analyses. TPH are not considered COPCs associated with waste management at SWMU 144. No VOCs typically associated with TPH were detected above comparative criteria, and no SVOCs were detected in shallow soil samples. These conditions confirm that TPH is not a risk to potential receptors.

6.14.5.4 *Metals*

6.14.5.4.1 Shallow Soil (0 to 10 ft bgs)

No metals were detected above the NMED SSLs for residential soil in shallow soils at SWMU 144. With the exception of ~~A~~arsenic, which is attributable to redox-related conditions at the HELSTF,no other metals were detected above the DAF 1 screening criteria in shallow soils at SWMU 144.~~and barium were the only metals detected in shallow soils. Neither metal was detected above NMED SSLs. As discussed in Section 4.3.6 (page 38), detections of arsenic and barium do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained these constituents. The arsenic and barium detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 1~~

6.14.5.4.2 Deep Soil (Greater than 10 ft bgs)

Arsenic, barium, selenium, and silver were detected above the DAF 1 in deep soils at SWMU 144. As discussed in Section 4.3.6 (page 44), detections of arsenic, barium, and selenium do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained these constituents. The arsenic, barium, and selenium detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 144.

Silver was detected in only one deep soil sample (HMW-27, 18.5 ft bgs) at SWMU 144, above the NMED DAF 1. This silver exceedance of the NMED DAF 1 standard was an isolated occurrence in deep soils. Silver was not detected in shallower soils at SWMU 144. This silver exceedance has been delineated. A figure indicating the location of the silver exceedance is provided as Figure 6.14-3, and a figure showing the general lateral delineation of silver in deep soils at the HELSTF is provided on Figure G-3 in Appendix G. ~~-3.as Figure G-3 in Appendix G.~~

6.14.5.5 ~~*Shallow Soil*~~ *Summary*

In summary, acetone was the only VOC COPC detected in shallow and deep soil at SWMU 144. Acetone was detected in ~~only one shallow~~ two soil samples from one location ~~below the SSL but~~ above the DAF 1 screening criterion. These~~is~~ exceedances are isolated and have ~~has~~ been delineated.

~~6.14.5.6~~ *Silver was the only metal COPC detected in soil at SWMU 144. Although silver was detected above the DAF 1 screening criterion in one deep soil sample, it has not been detected in the vadose zone water, which is encountered at approximately 39 to 40 ft bgs in Vadose Zone Wells HMW-07 and HMW-26. Also, ~~S~~silver has ~~also~~ not been detected in the Regional Aquifer in the vicinity of SWMU 144. Thus, constituent concentrations in soil at SWMU 144 are not a source of contamination to vadose zone water or the Regional Aquifer. In addition, there are no mechanisms currently present to mobilize the detected constituents. The wastewater discharges to the unlined pond that historically contributed to vadose zone water have been discontinued. ~~Deep Soil (Greater than 10 ft bgs)~~*

~~Soil samples were collected from depths greater than 10 feet from the following borings at SWMU 144: HMW-07, 144BG1, HMW-26, HMW-27, and HMW-28. One VOC (acetone) and six metals (arsenic, barium, chromium, lead, selenium, and silver) were~~

detected above laboratory reporting limits. Table 6.14-3 provides a statistical summary of data for deep soil and Table 6.14-4 provides a summary of exceedances of regulatory standards for deep soil at SWMU 144. Table 12 of Appendix D-2 provides a comprehensive summary of all of the SWMU 144 soil results.

6.14.5.6.1 VOCs

Acetone was the only VOC detected in the soils deeper than 10 ft bgs at SWMU 144. Acetone was detected in only 2 of the 15 deep soil samples designated for this analysis. Acetone was detected at HMW-07 at 5.10 mg/kg at 15 ft bgs and at 0.320 mg/kg at 20 ft bgs. The occurrences of acetone in soil at SWMU 144 are shown on Figure 6.14-2. The exceedances of the DAF 1 have been delineated. General lateral delineation of acetone in deep soils at the HELSTF is shown on Figure G-4 in Appendix G.

6.14.5.6.2 SVOCs

There were no SVOCs detected in deep soil (>10 ft bgs) at SWMU 144.

6.14.5.6.3 Other Parameters

TPH were detected in two of the nine deep soil samples designated for these analyses. TPH were detected at 20 mg/kg at 144B1 and at 28 mg/kg at 144BG1 (20 ft bgs). TPH are not considered COPCs associated with waste management at SWMU 144. Samples that were tested for TPH were also tested for full suites of VOCs and SVOCs that would comprise the TPH. The isolated VOC (acetone) is not a constituent associated with TPH. No other VOCs were detected above comparative criteria. No SVOCs were detected in shallow soil samples. These conditions confirm that TPH is not a risk to potential receptors.

6.14.5.6.4 Metals

Arsenic, barium, chromium, lead, selenium, and silver were detected in deep soils at SWMU 144. As discussed in Section 4.3.6 (page 38), detections of arsenic, barium, and selenium do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained these constituents. The arsenic, barium, and selenium detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 144.

~~Chromium was detected in all 3 of the deep soil samples and lead was detected in 8 of the 15 deep soil samples designated for these analyses. Neither of these metals was detected above regulatory standards.~~

~~6.14.5.6.5 Silver was detected in only 1 of the 15 deep soil samples designated for this analysis. Silver was detected at 18.0 mg/kg at HMW-27 (18.5 ft bgs), which was above the NMED DAF 1. This silver exceedance of the NMED DAF 1 standard was an isolated occurrence in deep soils. Silver was not detected in shallower soils at SWMU 144. This silver exceedance has been delineated. A figure indicating the location of the silver exceedance is provided as Figure 6.14-3.Deep Soil Summary~~

~~Acetone was detected in deep soils at only one location (HMW-07). The acetone detections at this one location have been delineated laterally and vertically. Although silver was detected above the DAF 1 in one soil sample, it has not been detected in the vadose zone water, which is encountered at approximately 39 to 40 ft bgs in Vadose Zone Wells HMW-07 and HMW-26. Silver has also not been detected in the Regional Aquifer in the vicinity of SWMU 144. Thus, constituent concentrations in soil at SWMU 144 are not a source of contamination to vadose zone water or the Regional Aquifer. In addition, there are no mechanisms currently present to mobilize the detected constituents. The wastewater discharges to the unlined pond that historically contributed to vadose zone water have been discontinued.~~

6.14.6 Human Health Risk Assessment Findings

Data collected during site characterization activities during the RFIs were used in the evaluation of risk to human health. A description of risk assessment methodologies and results is provided on page 177 of~~on page 166 of in~~ Appendix E.

The results of this data screening process indicate that after comparison to health-based soil screening levels for construction worker exposure, no COPCs were selected for combined surface and subsurface soil at SWMU 144. This demonstrates that the constituent concentrations in combined surface and subsurface soil at SWMU 144 are unlikely to result in adverse health impacts to the identified potential future receptors. No surface soil data were required to be collected for the Phase I, II or III RFI investigations. Therefore, surface soil at SWMU 144 was not identified as a medium of concern.

6.14.6.1 *Additionally, no COPCs were selected for saturated vadose zone soil water, indicating that vapor intrusion from saturated vadose zone soil water is unlikely to result in adverse health impacts. However, one VOC in total soil was selected as a COPC for the vapor intrusion evaluation. As summarized in table E.11.HHRA-10, the findings of the vapor intrusion evaluation indicate that potential future industrial or residential development of the site would result in potential indoor air exposures that are below the regulatory benchmarks for cancer risks and* non-cancer *hazards. Based on these results, additional human health risk assessment is not warranted for SWMU 144.* ~~– Soil Exposure Scenarios~~

~~In accordance with NMED guidance (NMED, 2006a), constituent concentrations in combined surface and subsurface soil were compared to health-based screening levels and the calculated ratios summed. The total ratios were less than the NMED target ratio of 1. The results of this data screening process indicate that after comparison to health-based SSLs for construction worker exposure, no COPCs were selected for combined surface and subsurface soil at SWMU 144. This demonstrates that the constituent concentrations in combined surface and subsurface soil (0 to 10 ft bgs) at SWMU 144 are unlikely to result in adverse health impacts to future construction workers via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, dermal).~~

~~No surface soil (0 to 2 ft bgs) data were required to be collected at SWMU 144 for the Phase I, II, or III RFI investigations. Therefore, surface soil at SWMU 144 was not identified as a medium of concern.~~

~~6.14.6.2 *Vapor Intrusion Scenarios*~~

~~6.14.6.3 *The one detected VOC in total soil (acetone) was selected as a COPC for the future vapor intrusion evaluation because there are no NMED or USEPA SSL screening levels that are protective of the vapor intrusion pathway. The total ELCR values for the future vapor intrusion exposure pathway could not be determined because acetone is not classified as a carcinogen. The total HI values for the vapor intrusion exposure pathway for the future site worker scenario and for the hypothetical future residential scenario are below the benchmark of 1, indicating adverse non-carcinogenic effects are unlikely to occur.*~~

~~Constituent concentrations in saturated vadose zone water were compared to the vapor intrusion screening levels for groundwater (USEPA, 2002c). The total ratios were less than the NMED target ratio of 1. The results of this data screening process~~

~~indicate that after comparison to health-based groundwater screening levels for protection of vapor intrusion, no COPCs were selected for saturated vadose zone water at SWMU 144.~~

6.14.7 Ecological Risk Assessment Findings

As described in the ERA presented on page 1~~78~~67 of Appendix E, a SLERA and BERA were completed for SWMU 144. After the SLERA, one constituent (i.e., acetone) was selected as a COPEC in combined surface and subsurface soil because the HQ was greater than 1. However, the only sample reporting a detection of acetone was collected from a depth of 10 ft bgs, which limits potential exposure to only deep burrowing receptors. Based on this information, and considering the size of the entire site is extremely small (approximately 0.06 acre), adverse impacts are not expected for terrestrial wildlife potentially exposed to acetone in subsurface soil at SWMU 144.

6.14.8 Conclusions and Recommendations

Silver and acetone were the only COPCs detected above a regulatory standard (i.e., the DAF 1). The silver exceedance was an isolated occurrence in an 18.5-foot sample from HMW-27. Although silver exceeded the DAF 1, it has not been detected in the vadose zone water, which is encountered at approximately 39 to 40 ft bgs, or in the Regional Aquifer in the vicinity of SWMU 144. Acetone exceedances were limited to soil~~s~~ from one boring location. Acetone has not been detected in vadose zone water or downgradient regional groundwater at SWMU 144. Thus, constituent concentrations in soil at SWMU 144 are not a source of contamination to vadose zone water or the Regional Aquifer. In addition, there are no mechanisms currently present to mobilize the detected constituents. The wastewater discharges to the unlined pond that historically contributed to vadose zone water were discontinued in 2008.

The results of the HHRA data screening process did not identify risks to current or future receptors. Therefore, no further HHRA is warranted. In addition, the results of the SLERA and BERA indicated there is adequate information to conclude that there are no significant current exposures to soil. The SLERA and BERA concluded that future adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in the subsurface soil. Therefore, no further ecological evaluation at SWMU 144 is warranted. ~~indicate that, after comparison to health-based soil screening levels for construction worker exposure, no COPCs were selected for combined surface and subsurface soil at SWMU 144. This demonstrates that the constituent concentrations in combined surface and subsurface soil at SWMU 144 are~~

~~unlikely to result in adverse health impacts to the identified potential future receptors. No surface soil data were required to be collected for the Phase I, II, or III RFI investigations. Therefore, surface soil at SWMU 144 was not identified as a medium of concern.~~

~~Additionally, no COPCs were selected for saturated vadose zone water, indicating that vapor intrusion from saturated vadose zone water is unlikely to result in adverse health impacts. However, one VOC (acetone) in total soil was selected as a COPC for the vapor intrusion evaluation. As summarized in Table E.11.HHRA-10 of Appendix E, the findings of the vapor intrusion evaluation indicate that potential future industrial or residential development of the site would result in potential indoor air exposures that are below the regulatory benchmarks for cancer risks and non-cancer hazards. Based on these results, additional HHRA is not warranted for SWMU 144.~~

~~A SLERA and BERA were completed for SWMU 144, to evaluate the combined surface and subsurface soil data set for ecological receptors. The results of the SLERA and BERA indicate there is adequate information to conclude that there are no significant current exposures to soil and future adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in the subsurface soil. Therefore, no further ecological evaluation at SWMU 144 is warranted.~~

No restrictions need to be applied to current or potential future land use for SWMU 144. No risks have been identified for human health or ecological receptors for exposures to the soil and vadose zone water at SWMU 144. Section 6.25 (page 351) discusses impacts to vadose zone water and regional groundwater which may be attributable to historical discharges to SWMU 144. Impacts in the vadose zone water and regional groundwater at the HELSTF will continue to be evaluated in a long-term monitoring program. The SWMU 144 soils are recommended for closure.

6.15 SWMU 145 – HELSTF Test Cell ~~4~~ Lagoons (WSMR-53)

6.15.1 Unit Description

The HELSTF Test Cell ~~4~~ Lagoon ~~s~~ is~~are~~ located approximately 600 feet west of the sewage lagoons (SWMUs 27 through 30) in the south-central section of the HELSTF. The dimensions of the unit ~~a~~were 105 feet by 60 feet by 6 feet deep. The unit was constructed with a single six-mil Hypalon® liner with no secondary containment. Although the current permit refers to SWMU 145 as Test Cell Lagoons, there was only one lagoon, which was historically referred to as the Test Cell 4 Lagoon.

6.15.2 Operational History

During 1989, a one-time discharge of 30,000 gallons of sodium fluoride wastewater was released into the lined lagoon. The wastewater level in the lagoon dropped 2 feet over a 2- to 3-day time frame, indicating that the integrity of the liner was compromised. The lagoon was not used again after this occurrence. The liner and contaminated soil were removed in 1996 (Dow Environmental [Dow], 1997).

The constituents of concern associated with this SWMU include calcium fluoride, sodium fluoride, and sodium hydroxide.

6.15.3 Regulatory History

~~Test Cell 4 Lagoon~~The SWMU was not addressed during the RFA conducted in 1988. Therefore, the site was not included in the 1989 RCRA Permit. The USAEHA identified the site during an evaluation of environmental conditions at the HELSTF in July 1990. As a result of this evaluation, the USAEHA recommended that additional assessment of this area be conducted as part of the Phase I RFI.

~~Additionally, o~~On August 7, 1991, the unit was added to the RCRA Permit for Appendix IV list sites that required additional investigation. As described under Section 6.15.4 (Investigative History, page 246), a Phase I RFI was conducted in 1992. Soil and groundwater data were collected during this investigation. These data showed low concentrations of detected parameters at or below background established for the Phase II RFI and/or 1992 regulatory levels. However, chloroform was detected in a groundwater sample at concentrations that exceeded 1992 action levels.

Based upon the results of the Phase I RFI, WSMR recommended NFA for the unit. In a letter dated January 22, 1993, NMED concurred with NFA. However, the USEPA did not agree with the recommendation due to the detection of chloroform in groundwater. The USEPA required that WSMR conduct a Phase II RFI to further investigate chloroform concentrations and recommended that the integrity of the liner be repaired (Honker, 1993).

As further described under Section 6.15.4 (Investigative History, page 246), a Phase II RFI was conducted in 1993/1994 that included collection of soil and groundwater samples from three new monitoring well locations. Groundwater samples were collected from an existing Phase I RFI monitoring well. Data collected during the

assessment indicated detections of metals, inorganics, and organics. The data comparisons indicated that the concentrations of selenium and fluoride appeared to have declined since then due to natural attenuation (SEI, 1994).

Both the NMED and the USEPA issued notices of deficiency related to the Phase II RFI. In general, they noted that detections of VOCs, fluoride, and metals identified in groundwater during the Phase II RFI above regulatory levels warranted a CMS to address the groundwater contamination (Honker, 1996; Kelly, 1996). Furthermore, the unit was required to be dismantled to assure that it was incapable of receiving additional wastes.

During 1996, the two steel inlet troughs, liner, and underlying 2 feet of soil were removed from the HELSTF Test Cell ~~4~~ Lagoons. The excavation was backfilled and the entire area was paved to prevent migration of related contaminants. A summary report documenting the removal action ~~was~~ prepared by Dow ~~that~~ was provided to the NMED on September 22, 1997.

WSMR submitted petitions for NFA in January 2000 and June 2001. The petitions were denied by NMED on March 11, 2002, because a final RFI report and ERA was required (Frischkorn, 2002). The annual unit audits and the current (2009) RCRA permit ~~continue to~~ list SWMU 145 as a SWMU that requires corrective action.

6.15.4 Investigative History

A summary of monitoring points used to investigate SWMU 145 is provided in Table ~~13 of Appendix D-2~~6-1~~5~~4. Descriptions of previous assessments are provided below.

Phase I RFI

The constituents of concern at this SWMU include calcium fluoride, sodium fluoride, and sodium hydroxide. Phase I RFI field activities included collection of a composite sediment sample (145SE1) from within Test Cell 4 Lagoon, collection of a background soil sample (145BG1), and advancement of an 80-foot soil boring that was completed as a vadose zone monitoring well (HMW-09). Soil samples were collected at 5-foot intervals from 10 to 35 ft bgs in the boring completed for the installation of HMW-09. A groundwater sample was collected from the newly installed Vadose Zone Monitoring Well HMW-09. Soil and groundwater samples were analyzed for VOCs, SVOCs, TPH, fluoride, and metals.

Analytical results indicated that low levels of arsenic and fluoride were detected in the shallow background soil sample. Results for the composite sediment sample collected from the Test Cell 4 Lagoon indicated low levels of arsenic, lead, fluoride, and TPH. Soil data collected from Vadose Zone Monitoring Well HMW-09 indicated detections of arsenic, barium, lead, and fluoride.

Groundwater data collected from HMW-09 indicated detections of selenium, fluoride, and chloroform (refer to Section 6.25 [page 351] and Tables 1 and 2 of Appendix D-26-24.1s 1 and 2 of Appendix D-3). Based upon the results of the assessment, it was concluded that there were no concentrated waste sources or indications of releases and NFA was recommended. NMED concurred with NFA; however, the USEPA did not agree with the recommendation due to the detection of chloroform in groundwater. The USEPA required that WSMR conduct a Phase II RFI to further investigate chloroform concentrations in groundwater (Honker, 1993).

Phase II RFI

During the Phase II RFI, three new monitoring wells (HMW-44, HMW-45, and HMW-46) were installed as vadose zone wells. Soil and groundwater samples were collected from the newly installed monitoring well locations. Groundwater was also collected from Phase I RFI Monitoring Well HMW-09. Two soil samples were collected from the boring for HMW-44 (18 and 38 ft bgs), two soil samples were collected from the boring for HMW-45 (19 and 39 ft bgs), and one sample was collected from the boring for HMW-46 (18 ft bgs). The soil samples were analyzed for VOCs, SVOCs, RCRA metals, and fluoride. Groundwater samples were analyzed for VOCs, SVOCs, total and dissolved RCRA metals, fluoride, and TDS.

No VOCs or SVOCs were detected above their respective quantification limits. Soil data collected from HMW-44, HMW-45, and HMW-46 indicated detections of arsenic, barium, chromium, lead, silver, and fluoride that were reported at concentrations below background established as part of the Phase II RFI and/or 1994 regulatory levels (Table 13 of Appendix D-2).

No SVOCs were detected in groundwater. Three VOCs were detected in groundwater collected during the Phase II RFI. Groundwater from HMW-44 contained 1,1-DCE above the MCL, and chloroform and 1,1,1-TCA above the 1994 action levels. Groundwater from HMW-09 and HMW-46 contained chloroform above the 1994 action levels. No VOCs were detected in HMW-45. Arsenic, barium, lead, mercury, and selenium were detected in groundwater from wells at SWMU 145. Concentrations of

lead, selenium, and fluoride were detected at levels that exceeded 1994 regulatory levels in groundwater samples. Groundwater from HMW-44, HMW-45, and HMW-46 all contained one or more metals above 1994 regulatory levels. Lead, selenium, and fluoride were detected above 1994 action levels in groundwater from HMW-44. Selenium and fluoride were also detected above the 1994 regulatory levels in groundwater from HMW-45 and HMW-46. A complete summary of groundwater conditions and sampling results is provided in Section 6.25 (page 351). Groundwater analytical results for the HELSTF are presented in Tables 1 and 2 of Appendix D-23. Based upon the data collected during the Phase II RFI, the Phase II RFI report concluded that data comparisons for selenium and fluoride detections indicated decreasing trends between 1991 and 1994. The report stated that the decrease could be attributed to natural attenuation.

Based upon the fact that there was a one-time release from a point source, the lagoon sediments, liner, and underlying 2 feet of soil were removed, and the vertical extent of contamination was limited to the vadose water zone, the Phase II RFI report concluded that soil delineation was not warranted. The presence of organic compounds detected in groundwater was attributed to releases from nearby sources not related to the Test Cell 4 Lagoon. It was recommended that assessment of the organic compounds in groundwater be included as part of a site-wide groundwater monitoring program.

Phase III

Prior to implementing the Phase III RFI, the steel inlet troughs, Hypalon® liner, and underlying 2 feet of soil were removed at Test Cell 4 Lagoon. The Phase III RFI program included installation of a new regional monitoring well (HMW-56) downgradient of SWMU 145. Additional groundwater data were collected from existing vadose zone Monitoring Wells HMW-09 and HMW-45. Vadose Zone Monitoring Wells HMW-44 and HMW-46 were dry during the Phase III RFI sampling event. Groundwater samples were analyzed for water quality parameters, dissolved ions, hexavalent chromium, chromium, silver, zinc, VOCs, and TOC.

In vadose zone water from HMW-09 and HMW-45, chromium and chloroform were detected below their respective NMED groundwater standards. Chloride, fluoride, and sulfate were detected in vadose zone water from both wells above NMED groundwater standards. None of the VOCs or metals analyzed were detected in groundwater from Regional Well HMW-56. Chloride, fluoride, and sulfate were present above NMED groundwater standards in groundwater from HMW-56. Section 6.25 (page 351) provides detailed information on groundwater conditions at the HELSTF and

groundwater analytical results are presented in Tables 6-221 and 6-223 of Appendix D-3.

6.15.5 Nature and Extent of Contamination in Soil

In order to delineate the extent of soil impacts at the HELSTF Test Cell 4 Lagoons (SWMU 145), five soil sampling locations that were advanced as part of Phase I and Phase II RFI-related activities were evaluated. The soil boring locations are shown on Figure 6.15-1, and a comprehensive data summary for soil is provided in Table 13 of Appendix D-26-154.

It should be noted that shallow sample 145SE1 was collected as a surface sediment sample before the liner and underlying soils were removed from the unit and the lagoon was backfilled. Therefore, this sample was not used in evaluating the nature and extent of impacts in soil at the unit.

~~6.15.5.1 *Shallow Soils (0 to 10 ft bgs)*~~

6.15.5.1 *VOCs*

6.15.5.1.1 Shallow Soils (0 to 10 ft bgs)

~~The only analyte detected in the two samples collected from shallow soil (• 10 ft bgs), 145BG1 (2 ft bgs), and HMW-09 (10 ft bgs), was arsenic. It should be noted that shallow sample 145SE1 was collected as a surface sediment sample before the liner and underlying soils were removed from the unit and the lagoon was backfilled. Therefore, this sample was not used in evaluating the nature and extent of impacts in soil at the unit. Table 6.15-1 provides a statistical summary of data for shallow soil and Table 6.15-2 provides a summary of exceedances of regulatory standards for shallow soil at SWMU 145.~~

~~VOCs~~

No VOCs were detected in shallow soils (• 10 ft bgs) at SWMU 145.

6.15.5.1.2 Deep Soil (Greater than 10 ft bgs)

No VOCs were detected above the DAF 20 screening criteria in deep soil at SWMU 145. ~~Acetone was the only VOC detected in deep soils at SWMU 145. Acetone was~~

~~detected in only one of the ten deep soil samples designated for this analysis, at a depth of 35 feet at HMW-09. Acetone is a common laboratory artifact and the detection is likely attributable to laboratory contamination. Additionally, it should be noted that this acetone detection is isolated to one sample collected at this SWMU and the concentration was below DAF 20. Therefore, the acetone detection is not being attributed to soil conditions at SWMU 145 and acetone is not considered a COPC associated with this SWMU.~~

6.15.5.2 *SVOCs*

~~6.15.5.1.1~~6.15.5.2.1 Shallow Soils (0 to 10 ft bgs)

No SVOC were detected in shallow soils (• 10 ft bgs) at SWMU 145.

6.15.5.2.2 Deep Soil (Greater than 10 ft bgs)

No SVOCs were detected in deep soils (>10 ft bgs) at SWMU 145.

6.15.5.3 *Other Parameters*

6.15.5.3.1 Shallow Soils (0 to 10 ft bgs)

Fluoride was detected in both of the shallow soil samples designated for this analysis (145BG1, 2 ft bgs, and HMW-09, 10 ft bgs). These detections were well below the NMED SSL for residential soil and the DAF ~~1~~20 screening value. TPH were analyzed in shallow soils at SWMU 145; none were detected.

6.15.5.3.2 Deep Soil (Greater than 10 ft bgs)

Fluoride was detected in eight of the ten deep soil samples designated for this analysis. None of the detections exceeded regulatory standards. Five deep soil samples were analyzed for TPH at SWMU 145. TPH were~~as~~ not detected in any of the five deep soil samples.

6.15.5.4 *Metals*

6.15.5.4.1 Shallow Soils (0 to 10 ft bgs)

No metals were detected above the NMED SSLs for residential soil or the DAF 20 screening criteria in the shallow soils at SWMU 145. Arsenic was detected in ~~both of the~~ shallow soil samples 145BG1 (2 ft bgs), and HMW-09 (10 ft bgs)at concentrations below NMED SSLs and DAF 20.~~designated for this analysis~~. ~~As discussed in Section 4.3.6 (page 41), detections of arsenic do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained these constituents. The arsenic detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 145.~~

6.15.5.4.2 Deep Soil (Greater than 10 ft bgs)

As shown on Table 6-154, arsenic was the only metal that was detected in deep soil at concentrations above DAF 20. The arsenic detections are attributable to ~~naturally occurring~~ redox-related conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 145.

~~6.15.5.2~~6.15.5.5 *Summary~~Shallow Soil Summary~~*

In summary, the only COPC associated with this SWMU is fluoride. Fluoride was detected in shallow and deep soil at concentrations wells below NMED regulatory standards.

~~6.15.5.3 *Deep Soil (Greater than 10 ft bgs)*~~

~~At the four locations (HMW-09, HMW-44, HMW-45, and HMW-46) where samples deeper than 10 ft bgs were collected, one VOC (acetone) and five metals (arsenic, barium, chromium, lead, and silver) were detected above laboratory reporting limits. A total of ten soil samples were collected from below 10 ft bgs at SWMU 145.~~
~~Table 6.15-3 provides a statistical summary of data for deep soil and Table 6.15-4 provides a summary of exceedances of regulatory standards for deep soil at SWMU 145.~~

~~6.15.5.3.1 VOCs~~

~~Acetone was the only VOC detected in deep soils at SWMU 145. Acetone was detected in only one of the ten deep soil samples designated for this analysis, at a depth of 35 feet at HMW-09. Acetone is a common laboratory artifact and the detection is likely attributable to laboratory contamination. Additionally, it should be noted that this acetone detection is isolated to one sample collected at this SWMU. Therefore, the acetone detection is not being attributed to soil conditions at SWMU 145 and acetone is not considered a COPC associated with this SWMU.~~

~~6.15.5.3.2 SVOCs~~

~~No SVOCs were detected in deep soils (>10 ft bgs) at SWMU 145.~~

~~6.15.5.3.3 Other Parameters~~

~~Fluoride was detected in eight of the ten deep soil samples designated for this analysis. None of the detections exceeded regulatory standards. Five deep soil samples were analyzed for TPH at SWMU 145. TPH was not detected in any of the five deep soil samples.~~

~~6.15.5.3.4 Metals~~

~~Arsenic, barium, chromium, lead, and silver were detected in deep soils at SWMU 145. As discussed in Section 4.3.6 (page 41), detections of arsenic and barium do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained these constituents. As The arsenic detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 145.~~

~~Chromium was detected in four of the five deeps soil samples and lead was detected in six of the 10 deep soil samples designated for these analyses at SWMU 145. There are no DAF 1 screening values for chromium and lead.~~

~~There were two detections of silver in the deep soils (>10 ft bgs); 8.88 mg/kg detected at HMW-44 at a depth of 18 ft bgs, and 11.9 mg/kg detected at HMW-45 at a depth of 19 ft bgs. Both detections exceed the NMED DAF 1 screening value of 1.57 mg/kg. These silver exceedances of the DAF 1 have been delineated, and silver has not been~~

~~detected in vadose zone water from HMW-09 or HMW-45 or in downgradient regional groundwater from HMW-56. Silver is not a COPC associated with SWMU 145 and will not be addressed further in regards to environmental conditions at SWMU 145.~~

~~6.15.5.3.5 Deep Soil Summary~~

In summary, the only waste received at this unit was a one-time release of sodium fluoride wastewater. Fluoride was not detected in soil above the NMED SSL or DAF ~~1~~ 20 at SWMU 145. Fluoride exceedances of the New Mexico groundwater standard in vadose zone water from HMW-09 and HMW-45, and in groundwater from downgradient Well HMW-56 are not likely attributable to the one-time release at this unit that occurred 20 years ago. A discussion of vadose zone and regional groundwater conditions is provided in Section 6.25 (page 351) and a summary of groundwater analytical results is provided in Tables 6-2~~1~~12 and 6. ~~2~~3 ~~of Appendix D-3~~.

6.15.6 Human Health Risk Assessment Findings

The data used for the HHRA and ERA consist of the same data sets used for the Revised Phase III RFI Report. The data are comprised of soil and saturated vadose zone water data collected during multiple RFI phases and routine groundwater monitoring activities. The primary sources of the soil and saturated vadose zone water data include the Phase I RFI (ITC, 1992), the Phase II RFI (SEI, 1993; 1994), and the Phase III RFI (WSMR, 2008). Risk assessment data sets for soil and saturated vadose zone water for SWMU 145 were compiled, summarized, and statistically analyzed per methods described on page 187~~176~~ of Appendix E.

The results of this data screening process indicate that after comparison to health-based soil screening levels for construction worker exposure, no COPCs were selected for combined surface and subsurface soil at SWMU 145. This demonstrates that the constituent concentrations in combined surface and subsurface soil at SWMU 145 are unlikely to result in adverse health impacts to the identified potential future receptors. No surface soil data were required to be collected for the Phase I, II, or III RFI investigations. Therefore, any exposure to surface soil at SWMU 145 by site workers or future residents is not expected to represent an exposure concern.

Additionally, no COPCs were selected for saturated vadose zone water and total soil at SWMU 145, indicating that vapor intrusion is unlikely to result in adverse health impacts. Based on these results, additional human health risk assessment is not warranted for SWMU 145.

6.15.7 Ecological Risk Assessment Findings

As described within the ERA presented on page 189~~177~~ of Appendix E, a screening-level risk assessment was completed for SWMU 145. There are no completed exposure pathways for ecological receptors under current conditions and no COPECs were identified for potential future exposures to soil. Based on the analysis of available information, there is adequate information to conclude that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in the soil. Therefore, no further ecological evaluation at SWMU 145 is warranted.

6.15.8 Conclusions and Recommendations

SWMU 145 has been closed and backfilled since 1996. The only waste received at this unit was a one-time release of sodium fluoride wastewater in 1989. Fluoride was not detected in soil above the NMED SSL or DAF ~~1~~ 20 at SWMU 145. Fluoride exceedances of the New Mexico groundwater standard in vadose zone water from HMW-09 and HMW-45, and in groundwater from downgradient Well HMW-56 are not likely attributable to a one-time release at this unit that occurred 20 years ago.

No risks to current or future receptors were identified by the ~~An~~ HHRA. Therefore, no further HHRA is required. In addition, the results of the SLERA indicate there is adequate information to conclude that there are no significant current exposures to soil and future adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in the soil. Therefore, no further ecological evaluation at SWMU 145 is warranted.~~was conducted to evaluate exposure to COPCs in surface soil, combined surface and subsurface soil, total soil, and saturated vadose zone water for site workers under current and future land-use conditions, and construction workers and residents (adult and child) under hypothetical future land-use conditions. The constituent concentrations in combined surface and subsurface soil at SWMU 145 are unlikely to result in adverse health impacts to the identified potential future receptors. No surface soil data were required to be collected for the Phase I, II, or III RFI investigations. Therefore, any exposure to surface soil at SWMU 145 by site workers or future residents is not expected to represent an exposure concern.~~

~~Additionally, no COPCs were selected for saturated vadose zone water and total soil at SWMU 145, indicating that vapor intrusion is unlikely to result in adverse health impacts. Based on these results, additional human health risk assessment is not warranted for SWMU 145.In accordance with NMED guidance (NMED, 2006a), constituent concentrations in surface soil and in combined surface and subsurface soil~~

~~were compared to health-based screening levels and the calculated ratios summed. The total ratios were less than the NMED target ratio of 1. The results of this data screening process indicate that after comparison to health-based soil screening levels for construction worker exposure, no COPCs were selected for combined surface and subsurface soil at SWMU 145. This demonstrates that the constituent concentrations in combined surface and subsurface soil at SWMU 145 are unlikely to result in adverse health impacts to future construction workers via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, dermal).~~

~~No surface soil data were required to be collected for the Phase I, II, or III RFI investigations. Therefore, any exposure to surface soil at SWMU 145 by site workers or future residents is not expected to represent an exposure concern.~~

~~The results of this data screening process indicate that after comparison to health-based screening levels for protection of indoor air, no COPECs were selected for saturated vadose zone water and total soil at SWMU 145. This demonstrates that the constituent concentrations in saturated vadose zone water and total soil at SWMU 145 are unlikely to result in adverse health impacts to the following potential receptors via inhalation of indoor air:~~

- ~~Future site workers; and~~
- ~~Future residents (adults and children).~~

~~A SLERA was completed for SWMU 145 to evaluate surface soil and subsurface soil for ecological receptors. The results of the SLERA indicate there is adequate information to conclude that there are no significant current exposures to soil and future adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in the soil. Therefore, no further ecological evaluation at SWMU 145 is warranted~~There are no environmental impacts associated with SWMU 145 as a result of historical site activities and no restrictions need to be applied to current or potential future land use at the site. Accordingly, the site is recommended for NFA and should be closed out of the RCRA process.

FINAL

6.16 SWMU 146 – STP Dry Pond (CCWS-03; WSMR-45)

6.16.1 Unit Description

~~This unit~~ SWMU 146, the STP Dry Pond, is located approximately 400 feet southwest of the HELSTF sewage lagoons (formerly SWMUs 27 through 30, now SWMU 27). This unit consists of an unlined surface impoundment with dimensions of 120 feet by 120 feet by 7 feet deep. The unit formerly served as an overflow for treated wastewater from the HELSTF sewage lagoons ~~(SWMUs 27 through 30)~~ on an as-needed base and received all non-sewage wastewater from Test Cell 2 Mechanical Building 26115.

6.16.2 Operational History

The unit was constructed around 1981 and received treated wastewater effluent until sometime in 2008. On July 22, 1983, the USACE petitioned the State for several~~parate~~ approvals in relation to the operation of the domestic wastewater system at the HELSTF. One of the requests was for permission to discharge 15,000 gallons of domestic sewage to the unlined percolating lagoon southwest of the existing lined lagoons, now known as the Dry Pond (SWMU 146). This one-time discharge was needed because the existing sanitary wastewater treatment system that then consisted of SWMUs 27 and 28 was hydraulically overloaded. The regulatory agency approved the one-time discharge of 15,000 gallons of domestic sewage on September 6, 1983.

~~Subsequent discharges have occurred from SWMUs 27 through 30 on an as-needed basis. In addition, the Dry Pond received effluent from Building 26115 at a rate of 30 to 50 gpm. As a result of this discharge from Building 26115, gypsum that comprises the subsoil has been dissolved to approximately 7.5 ft bgs. The effluent readily flowed into a cavity formed by the discharge. Due to this condition, the pond did not contain any effluent while in operation, thus giving it the name "Dry Pond".~~On October 25, 1984, the state granted permission for WSMR to discharge 15,000 gallons per day to the HELSTF STP Dry Pond (SWMU 146) for 120 days to handle excess water discharged to the sewage lagoons. The source of the excess water was identified as cooling tower water, PRS pump cooling water, and PRS boiler water. The facility submitted Discharge Plan DP-386 on March 28, 1985, to discharge 41,300 gallons per day to the HELSTF STP Dry Pond (SWMU 146). On November 5, 1985, the state granted permission to discharge only the cooling tower water and pump cooling tower water (but not the PRS boiler water) without a permit.

Subsequent discharges have occurred from SWMUs 27 through 30 on an as-needed basis. In addition, the Dry Pond received effluent from Building 26115 at a rate of 30 to 50 gpm. As a result of tThis discharge from Building 26115, caused the gypsum that comprises the subsoil has been to dissolved to approximately 7.5 ft bgs. The effluent readily flowed into athe cavity formed by the discharge. Due to this condition, the pond did not contain any effluent while in operation, thus giving it the name "Dry Pond".

The potential contaminants associated with SWMU 146 include those constituents associated with treated sewage and industrial wastewater, including cooling water containing hexavalent chromium, detergents, and solvents.

6.16.3 Regulatory History

The Dry Pond was not addressed during the RFA conducted during 1988. Therefore, the site was not included in the 1989 RCRA Permit. The USAEHA identified the Dry Pond during an evaluation of environmental conditions at the HELSTF in July 1990. The unit was subsequently added to the RCRA Permit as an Appendix IV site on August 7, 1991, that required additional investigation. SWMU 146 is listed on the current (2009) facility permit as a SWMU requiring corrective action (NMED, 2009).

Assessment of conditions at this SWMU was conducted as part of the Phase I RFI. As further described in Section 6.16.4 (Investigative History, page 258), an effluent sample and soil and groundwater samples were collected as part of the Phase I RFI. The effluent sample had low concentrations of hexavalent chromium and chlorodibromomethane. Metals were detected at concentrations below the 1992 action levels in shallow soils within the SWMU boundaries and in a deep boring outside of the SWMU boundaries. In summary, soil data did not indicate significant detections of site parameters (ITC, 1992). Selenium and chloroform were detected in a groundwater samples collected from newly installed monitoring wells. Based upon the results of the Phase I RFI, NFA for this unit was recommended, but the report recommended for ongoing monitoring of the wastewater discharge and nearby monitoring wells for as long as the discharge continued.

In a letter dated January 22, 1993, NMED concurred with the NFA request as long as WSMR was willing to commit to an ongoing groundwater monitoring program in the HELSTF. However, the USEPA did not agree with the recommendation for NFA due to the detection of chloroform in groundwater. The USEPA required that WSMR conduct a Phase II RFI to further investigate chloroform concentrations in groundwater (Honker 1993).

The Phase II RFI was conducted and the assessment included collection of a wastewater effluent sample, soil samples and groundwater samples for analyses. As further described under Section 6.16.4 (Investigative History, page 258), no constituents analyzed were detected in the effluent sample. Metals were detected in soil and groundwater. VOCs were also detected in groundwater samples (SEI, 1994).

Based upon the results of the Phase II RFI, WSMR concluded that there was no significant evidence of a release of contaminants from SWMU 146 and that the overall groundwater quality data appeared to be representative of groundwater quality known to exist in the HELSTF area. WSMR proposed NFA for this SWMU due to these conditions. WSMR further recommended to periodically monitoring the active discharge and nearby monitoring wells.

In response to the Phase II RFI Report, NMED and the USEPA issued notices of deficiencies on May 23, 1996, and September 4, 1996, respectively, and requested further evaluation of the human health and ecological risk, including a CMS (Frischkorn, 2002). The USEPA also required that pollution prevention/abatement measures be taken and groundwater monitoring be implemented.

WSMR submitted petitions for NFA for this site and others in January 2000 and September 2001. The petition was denied by NMED on March 11, 2002, because a final RFI report and an ERA were required. In addition, a background soil study to rule out arsenic as a soil contaminant and data showing that groundwater contamination is resulting from another source was required. The annual audits checklist indicates that SWMU 146 is a SWMU requiring corrective action.

6.16.4 Investigative History

A summary of ~~monitoring points~~soil sampling locations used to investigate SWMU 146 is provided in Table 6-16 and the soil sampling locations are shown on Figure 6.16-1. ~~of Appendix D-2~~ Descriptions of assessments are provided below.

Phase I RFI

The Phase I RFI for the HELSTF STP Dry Pond included collection of a background soil sample (146BG1, shown in the Phase I summary table as 146BKG), collection of four shallow soil samples from inside the pond (146S1 through 146S4), collection of a wastewater effluent sample (146EF01), and installation and groundwater sampling of Monitoring Wells HMW-06B and HMW-05. It should be noted that HMW-06B was

believed to be a Regional Aquifer well. However, information collected during subsequent investigations indicates that this well is actually monitoring the vadose zone water, as is HMW-05. Soil samples were also collected from the HMW-06B borehole at 5-foot intervals from 10 to 40 ft bgs. All samples were analyzed for VOCs, SVOCs, metals, and TPH. The effluent sample was also analyzed for hexavalent chromium.

Soil data indicated that the background sample contained arsenic below the 1992 regulatory level. Of the four shallow soil samples collected from within the pond, only arsenic and selenium were detected, and they were present at concentrations below 1992 action levels. Soil data collected from HMW-06B indicated concentrations of arsenic, barium, and lead generally below 1992 action levels. Lead and arsenic were slightly elevated in the soil sample collected from 25 ft bgs at HMW-06B, but were below the 1992 proposed regulatory standards.

Selenium and chloroform were detected in groundwater from HMW-05, and arsenic, chloroform, and TPH were detected in groundwater from HMW-06B. Chloroform was detected at concentrations above 1992 federal action levels.

Hexavalent chromium, chloroform, and chlorodibromomethane were detected below their respective 1992 action levels in the wastewater effluent.

In the Phase I RFI report, WSMR concluded that constant, high-volume wastewater discharge to SWMU 146 that included overflow from SWMUs 27 through 30 did not result in a significant release of contaminants. Based upon these conditions, NFA for this unit was recommended. However, the USEPA did not agree with the recommendation due to the detection of chloroform in groundwater. The USEPA required that WSMR conduct a Phase II RFI to further investigate chloroform concentrations in groundwater (Honker, 1993).

Phase II RFI

During the Phase II RFI, a wastewater effluent sample, soil samples, and groundwater samples were collected for analyses. Five vadose zone monitoring wells (HMW-20 through HMW-24) were installed. Seven soil samples were collected for analyses prior to well installation, as follows: (146MW20 at 22 ft bgs, 146MW21 at 46 and 59 ft bgs, 146MW22 at 19 ft bgs, 146MW23 at 38 ft bgs, and 146MW24 at 20 and 36 ft bgs). Groundwater samples were collected from the newly installed monitoring wells, existing Phase I RFI monitoring wells (HMW-05 and HMW-06B), and nearby Monitoring Well

HMW-19 adjacent to SWMU 34. All samples were analyzed for VOCs, SVOCs, metals, and hexavalent chromium. Groundwater was also analyzed for TDS.

None of the constituents analyzed in the wastewater effluent were detected.

No SVOCs were detected in soil at SWMU 146. Acetone was the only VOC detected in two soil samples (146MW21 at 46 and 59 ft bgs) at concentrations below 1994 regulatory action levels. These acetone detections can be attributed to laboratory contamination and are not considered as constituents of concern indicative of a release from SWMU 146. Several metals were detected in soil samples: arsenic, barium, and chromium were detected in most of the seven samples, but not at levels that exceeded their respective action levels. Elevated concentrations of lead and selenium were detected at 22 ft bgs in the HMW-20 boring and at 19 ft bgs in the HMW-22 boring. Silver was detected at an elevated level at 36 ft bgs in the soil sample collected at HMW- 24.

No SVOCs were detected in groundwater at SWMU 146. Five VOCs were detected in eight groundwater samples, but only three were detected above the 1994 action levels. The detected VOCs that exceeded 1994 action levels ~~included~~ were 1,1-DCE in groundwater from HMW-05 and HMW-06B, and ~~. Concentrations of~~ 1,1,1-TCA and carbon tetrachloride ~~were also detected above 1994 action levels~~ in groundwater ~~samples collected~~ from HMW-06B.

Metals were detected in all of the groundwater samples. However, only two exceeded their respective 1994 action levels. The total lead concentration (16 µg/L) at HMW-19 was just above the Federal action level in 1994 (15 µg/L). However, there was no dissolved lead detected in that same sample. Concentrations of selenium were detected above the MCL of 10 µg/L in groundwater from HMW-19 (total and dissolved), HMW-20 (total), HMW-21 (dissolved), and HMW-24 (total and dissolved).

Based upon the results of the Phase I and II RFIs, WSMR concluded that there was no significant evidence of a release of contaminants from SWMU 146 and that operations at Building 26115 have not and do not pose a significant threat to human health or the environment. In addition, WSMR stated that the overall groundwater quality data collected during the Phase II RFI appeared to be representative of groundwater quality known to exist in the HELSTF area. WSMR proposed NFA for this SWMU due to these conditions. Additional monitoring of the effluent and groundwater from nearby monitoring wells was recommended for this SWMU.

NMED and the USEPA issued notices of deficiencies for the Phase II RFI report. Both agencies noted that various organic and inorganic compounds were detected above the regulatory limits in soil and groundwater. Further evaluation of the human health and ecological risk was required and a CMS was requested. In addition, the USEPA required that pollution prevention/abatement measures be taken and groundwater monitoring be implemented.

Phase III RFI

As part of the Phase III RFI, six soil samples were collected from each of five 50-foot borings (HLSF-SB-032 through HLSF-SB-036) from 0.5 to 1, 10 to 11, 20 to 21, 30 to 31, 40 to 41, and 49 to 50 ft bgs. Soil samples were analyzed for RCRA metals, zinc, hexavalent chromium, sodium, potassium, TOC, phosphorus, DRO, GRO, and VOCs. None of the constituents exceeded the NMED SSLs in the upper 10 ft. Only arsenic, which is attributed to redox~~naturally occurring~~, exceeded its DAF 20 criterion.~~With the exception of the naturally occurring parameters such as sodium, phosphorus, potassium, and TOC, arsenic, barium, and zinc were the only constituents detected. None of the barium or zinc detections exceeded the SSL for residential soil, and only one barium detection at 30 to 31 ft bgs in the boring for HMW-SB-033 exceeded the NMED DAF 1 level. Arsenic exceedances were detected in deep soils in all of the Phase III RFI borings, from between 20 and 41 ft bgs.~~

A monitoring well (HMW-57) was installed downgradient of SWMU 146 to collect groundwater from the Regional Aquifer. In addition, groundwater was also to be sampled from seven existing monitoring wells (HMW-05, HMW-06B, and HMW-20 through HMW-24). However, HMW-05, HMW-06B, HMW-20, HMW-21, and HMW-22 were all dry at the time the Phase III RFI groundwater sampling activities were conducted in December 2006. Groundwater was analyzed for water quality parameters, ammonia-nitrogen, dissolved ions, phosphorus, hexavalent chromium, cadmium, chromium, copper, lead, sodium, zinc, alcohols, VOCs, and TOC. Constituents such as chloride, fluoride, and sodium are considered naturally occurring parameters in water at the HELSTF, as discussed in Section 6.25 (page 351). No VOCs, SVOCs, or metals were detected above regulatory standards in vadose zone water from HMW-23. No VOCs or SVOCs were detected above regulatory standards in HMW-24; however, selenium was detected above the NMED groundwater standard in vadose zone water from HMW-24. A complete discussion of groundwater conditions at the HELSTF is provided in Section 6.25 (page 351) and summary tables of groundwater analytical results are in Tables 6-22~~.25-1~~ and 6~~.25~~-23.

6.16.5 Nature and Extent of Contamination in Soil

~~In order to delineate the extent of soil impacts at the Dry Pond (SWMU 146), analytical results for 49 soil samples from 17 soil boring locations that were advanced as part of all RFI-related activities were evaluated~~The soil boring locations used to evaluate SWMU 146 are shown on Figure 6.16-1, and a comprehensive data summary for soil is provided in Table 6-1~~56 of Appendix D-2~~.

6.16.5.1 ~~*Shallow Soil (0 to 10 ft bgs)*~~*VOCs*

6.16.5.1.1 Shallow Soil (0 to 10 ft bgs)

No VOCs were detected in shallow soil at SWMU 146.~~A total of 13 shallow soil samples were collected during all of the RFI activities at SWMU 146. There were no exceedances of the SSLs in the upper 10 feet of soil at the Dry Pond (SWMU 146). Table 6.16-1 provides a statistical summary of data for shallow soil and Table 6.16-2 provides a summary of exceedances of regulatory standards for shallow soil at SWMU 146.~~

~~6.16.5.1.1 VOCs~~

6.16.5.1.2 Deep Soil (Greater than 10 ft bgs)

No VOCs were detected above the DAF 20 screening criteria in deep soil at SWMU 146.~~No VOCs were detected in the shallow soil (• 10 ft bgs) of SWMU 146.~~

6.16.5.2 *SVOCs*

6.16.5.2.1 Shallow Soil (0 to 10 ft bgs)

No SVOCs were detected above the SSLs or the DAF 20 criteria in shallow soil at SWMU 146.

6.16.5.2.2 Deep Soi (Greater than 10 ft bgs)l

No SVOCs were detected in deep soil at SWMU 146.

~~Di-n-butylphthalate was detected in one of the six shallow soil samples designated for this analysis. This constituent was detected at 0.57 mg/kg from the surface at the~~

~~background sample location 146BB1, which was well below the NMED SSL and DAF 1 screening value. This is an isolated detection and it occurred at the background sample collected outside the boundaries of SWMU 146. Based on the isolated occurrence and knowledge of the historical waste management operations at SWMU 146, di-n-butylphthalate is not considered a COPC for SWMU 146.~~

6.16.5.3 *Metals*

6.16.5.3.1 Shallow Soil (0 to 10 ft bgs)

There were no metals detected in shallow soils (• 10 ft bgs) at concentrations exceeding the SSLs for residential soil at SWMU 146. Only arsenic, which is attributable to redox-related conditions at the HELSTF, was detected in shallow soil at concentrations exceeding the DAF 20 criterion.

6.16.5.3.2 Deep Soil (Greater than 10 ft bgs)

With the exception of arsenic and selenium, which are naturally occurring, no metals were detected above the DAF 20 criteria in deep soil at SWMU 146.~~Arsenic, barium, cadmium, chromium, lead, potassium, selenium, sodium, and zinc were all detected in shallow soils at SWMU 146. As discussed in Section 4.3.6 (page 38), detections of arsenic, barium, and selenium do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained these constituents. The arsenic, barium, and selenium detections, in addition to sodium and potassium, are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 146.Cadmium was detected in 1 of the 11 shallow soil samples, chromium and zinc were detected in all five of the shallow soil samples, and lead was detected in 2 of the 11 shallow samples designated for these analyses. None of the cadmium, chromium, zinc, or lead detections in shallow soil exceeded their respective NMED SSL values and none of the cadmium or zinc detections exceeded their DAF 1 screening values. There are no DAF 1 screening values for chromium and lead.~~

~~6.16.5.3.1 Shallow Soil Summary~~

~~In summary, there were no COPCs detected above regulatory standards in shallow soils (• 10 ft bgs) at SWMU 146.~~

6.16.5.4 *Deep Soil (Greater than 10 ft bgs)*

At the 11 soil boring locations where samples deeper than 10 ft bgs were collected, 9 metals (arsenic, barium, chromium, lead, potassium, selenium, silver, sodium, and zinc) and 1 VOC (acetone) were detected. Table 6.16-3 provides a statistical summary of data for deep soil and Table 6.16-4 provides a summary of exceedances of regulatory standards for deep soil at SWMU 146.

6.16.5.4.1 VOCs

Acetone was the only VOC detected in soils deeper than 10 ft bgs at SWMU 146. Acetone was detected in 2 of the 36 deep soil samples analyzed it, with both detections in soil samples from HMW-21 (46 and 59 ft bgs). Acetone is a common laboratory artifact and the detection is likely attributable to laboratory contamination. Additionally, it should be noted that this acetone detection is isolated to two samples from one location at this SWMU. Therefore, the acetone detection is not attributed to soil conditions at SWMU 146 and acetone is not considered a COPC associated with this SWMU.

6.16.5.4.2 SVOCs

No SVOCs were detected in soils deeper than 10 ft bgs at SWMU 146.

6.16.5.4.3 Metals

Nine metals (arsenic, barium, chromium, lead, potassium, selenium, silver, sodium, and zinc) were detected in deep soils at SWMU 146. As discussed in Section 4.3.6 (page 38), detections of arsenic, barium, and selenium do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained these constituents. The arsenic, barium, and selenium detections, in addition to sodium and potassium, are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 146.

Chromium was detected in 28 of the 30 deep soil samples, lead was detected in 31 of the 35 deep soil samples, and zinc was detected in all 24 deep soil samples designated for these analyses. None of the zinc detections exceeded the DAF 1 screening value in deep soil at SWMU 146. There are no DAF 1 screening criteria for chromium and lead.

~~Silver was detected in 4 of the 35 deep soils at SWMU 146 as follows: 9.50 mg/kg at 22 ft bgs at HMW-20, 8.53 mg/kg at 19 ft bgs at HMW-22, and 12.6 and 27.0 mg/kg at 20 ft bgs and 36 ft bgs, respectively at HMW-24. All four of these detections exceeded the NMED DAF 1 screening value of 1.57 mg/kg. All of these silver exceedances of the DAF 1 screening value occurred at borings located well outside of the SWMU boundaries and are shown on (Figure 6.16-2). It should be noted that silver was not detected in vadose zone water from HMW-21, HMW-23, or HMW-24 or in downgradient regional groundwater from HMW-57 and HMW-58.~~

~~6.16.5.5~~6.16.5.4 ~~*Deep Soil*~~ *Summary*

In summary,~~-~~ no COPCs were detected in soil at SWMU 146.~~silver is the only COPC detected above a regulatory standard in deep soils (>10 ft bgs) at SWMU 146. Silver was not detected in vadose zone water or regional groundwater in the vicinity of SWMU 146. Thus, silver occurrences in soil do not represent a source of impacts to the vadose zone water or regional groundwater.~~

6.16.6 Human Health Risk Assessment Findings

The results of the HHRA for SWMU 146 are presented on page 197 of Appendix E. The results of this data screening process indicate that after comparison to health-~~-~~based soil screening levels for industrial worker exposure, residential exposure, and *construction worker exposure, no COPCs were selected for surface soil, or for combined surface and subsurface soil at SWMU 146. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMU 146 are unlikely to result in adverse health impacts to the identified current and potential future receptors. Additionally, no COPCs were selected for saturated vadose zone soil water at SWMU 146 and no VOCs were detected in soil, indicating that vapor intrusion is unlikely to represent an exposure concern. Based on these results, additional human health risk assessment is not warranted for SWMU 146.*~~*Soil Exposure Scenarios*~~

~~In accordance with NMED guidance (NMED, 2006a), constituent concentrations in surface soil and in combined surface and subsurface soil were compared to health-based screening levels and the calculated ratios summed. The total ratios were less than the NMED target ratio of 1. The results of this data screening process indicate that after comparison to health-based SSLs for industrial worker exposure, residential exposure, and construction worker exposure, no COPCs were selected for surface soil or for combined surface and subsurface soil at SWMU 146. This demonstrates that the~~

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~~constituent concentrations in surface soil and in combined surface and subsurface soil at SWMU 146 are unlikely to result in adverse health impacts to the following potential receptors via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, dermal):~~

- ~~Current and future site workers;~~
- ~~Future residents (adults and children); and~~
- ~~Future construction workers.~~

~~6.16.6.1 Vapor Intrusion Scenarios~~

~~The results of this data screening process indicate that after comparison to health-based screening levels for protection of indoor air, no COPCs were selected for saturated vadose zone water at SWMU 146. In addition, no VOCs were detected in total soil. Therefore, no COPCs were identified for the vapor intrusion evaluation at SWMU 146. This demonstrates that the constituent concentrations in saturated vadose zone water and total soil at SWMU 146 are unlikely to result in adverse health impacts to the following potential receptors via inhalation of indoor air: Future site workers; and~~

- ~~Future residents (adults and children).~~

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6.16.7 Ecological Risk Assessment Findings

As described within the ERA presented on page 198 of~~on page 187 of in~~ Appendix E, a SLERA and BERA were completed for SWMU 146. After the SLERA, one constituent (i.e., selenium) was selected as a COPEC in combined surface and subsurface soil because the HQs were greater than 1. In the BERA, selenium was retained for further evaluation in the food chain modeling because it was identified as bioaccumulative.

Tables E.13.ERA-5 and E.13.ERA-6 of Appendix E summarize the constituents in combined surface and subsurface soil that were carried through the BERA and evaluated in the terrestrial food chain model. As shown in these tables, all receptors evaluated in the terrestrial food chain refined scenarios had LOAEL and NOAEL HQs less than 1. Based on the overall analysis of the ERA for SWMU 146, the results indicate that if subsurface soil exposure were to occur, then adverse effects are not expected for wildlife that may access the site.

6.16.8 Conclusions and Recommendations

The discharges to SWMU 146 ceased in 2008. Due to a decrease in discharge volume, a number of the vadose wells were dry during the Phase III sampling event in 2006. There is no ongoing source of potential contamination to the environment. No COPCs were detected in soil at SWMU 146. ~~Silver was detected above the NMED DAF 1 screening value in only 4 of the 35 deep soil samples designated for this analysis. There is no information indicating that silver is a COPC associated with wastes managed at SWMU 146, but there is not enough information to eliminate it from consideration. Silver has not been detected in vadose zone water or downgradient regional groundwater at SWMU 146.~~

The results of the data screening process for the HHRA indicate that, after comparison to health-based SSLs for industrial worker exposure, residential exposure, and construction worker exposure, no COPCs were selected for surface soil, or for combined surface and subsurface soil at SWMU 146. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMU 146 are unlikely to result in adverse health impacts to the identified current and potential future receptors. Additionally, no COPCs were selected for saturated vadose zone water at SWMU 146 and no VOCs were detected in soil, indicating that vapor intrusion is unlikely to represent an exposure concern. Based on these results, additional HHRA is not warranted for SWMU 146.

A SLERA and BERA were completed for SWMU 146, to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents detected in surface soil and subsurface soil, and to conduct food chain modeling for the COPEC identified as bioaccumulative (i.e., selenium). The results of the SLERA and BERA for direct contact exposure and for food chain modeling indicate there is adequate information to conclude that potential current and future impacts are unlikely to occur for ecological receptors potentially exposed to constituents in soil. Therefore, no further ecological evaluation at SWMU 146 is warranted.

Based on the results of the RFI, the fact that there is no residual source mass in the soils and because there is no longer a discharge to SWMU 146, the site is recommended for NFA and should be closed out of the RCRA process.

6.17 SWMU 147 – Decontamination Pad and Underground ~~Storage~~ Holding Tank (WSMR-78)

6.17.1 Unit Description

The Decontamination Pad and Underground ~~Storage~~Holding Tank are located adjacent to the southeast exterior corner of the HELSTF Building 26131 (the Cleaning Facility). The sump at this unit was closed ~~during~~ in ~~1~~1996. The Phase I and Phase II RFI reports state that the unit consisted of a 4-foot by 5-foot by 3-foot-deep underground tank with an open top covered by a grate and a steel cover. Wastewater and debris from the decontamination pad flowed into a drain and then to a sump before flowing to the underground tank (ITC, 1992b). During the Phase II RFI, based on historical drawings, it was reported that the sump discharged to an aboveground tank instead of an underground tank. According to the Phase II RFI report, the sump was covered with a steel plate secured with bolts, and the sump measured approximately 5 feet long by 3 feet wide by 6.7 feet deep (SEI, 1994). The drawings showed two lines going into the sump and one leaving at its north end of the sump (Giblin, 1993).

6.17.2 Operational History

The unit operated between 1982 and 1996. The pad was occasionally used for cleaning large pieces of equipment that could not be cleaned inside Building 26131 (Cleaning Facility). Wastewater/debris from the decontamination pad flowed down the drain and into a sump prior to entering the tank. Periodically, wastewater from the tank was removed for disposal. Based on historical drawings, it is now believed that the unit connected to an aboveground tank (SEI, 1994). However, there was no information that specified which AST was connected to the sump. It is believed that the sump may have connected to SWMUs 23 and 24 (~~Old~~ Hazardous Waste Tanks at HELSTF) (WTS, 2006). The sump was filled with concrete in April 1996 to prevent its continued use.

The contaminants potentially associated with SWMU 147 are solvent wastes, detergents, and petroleum oil and lubricants.

6.17.3 Regulatory History

SWMU 147, ~~The~~ Decontamination Pad and ~~Underground~~Holding Tank, were not addressed during the RFA conducted during 1988. Due to this condition, the site was not included in the 1989 RCRA Permit. The USAEHA conducted an evaluation of

environmental conditions at the HELSTF in July 1990. The unit was subsequently added to the RCRA Permit Appendix IV sites that required additional investigation on August 7, 1991. SWMU 147 is listed on the facility's current (2009) RCRA permit as a SWMU requiring corrective action (NMED, 2009).

Assessment of conditions at this SWMU was conducted as part of the Phase I RFI. As further described in Section 6.17.4 (Investigative History, page 270), soil samples were collected as part of the Phase I RFI. Data collected during the RFI indicated detections of a few VOCs, SVOCs, and metals below 1992 action levels and detections of TPH that exceeded 1992 action levels. However, the detections were attributed to releases identified at SWMUs 142 and 154. Based upon this condition, NFA was recommended for SWMU 147.

The NMED and the USEPA did not agree with the conclusions of the Phase I RFI for this SWMU. In correspondence dated January 22, 1993, the NMED requested that a tank tightness test be conducted on the underground tank (sump), and indicated that it must comply with underground storage tank (UST) regulations (Morgan, 1993a). The USEPA did not believe that analyses for TPH adequately assisted in evaluating organic constituents that could exist beneath the site and also voiced concern regarding the tank's integrity. The USEPA required additional assessment and analysis for organic parameters (Honker, 1993).

Phase II RFI activities were conducted at SWMU 147. As further described under Section 6.17.4 (Investigative History, page 270), modifications to the proposed field activities occurred at the time of the field program. In lieu of the proposed activities, collection of water and sediment samples from the sump was conducted (SEI, 1994). Results indicated elevated concentrations of four VOCs and one SVOC above their 1994 regulatory action levels in water. Five VOCs, two above their 1994 regulatory action levels, were detected in the sump sediment. One SVOC and TPH were detected above 1994 action levels in the sump sediment sample. Total chromium and lead concentrations were detected above 1994 action levels in the sump sediment, but were not detected by TCLP analysis.

It should be noted that it was determined during the Phase II field activities that the underground tank was actually ~~a~~the sump. Based upon this condition, WSMR and its contractor decided that it was not necessary to conduct a tank tightness test (SEI, 1994).

In response to the~~se findings~~ Phase II sampling results, the inlet pipes to the sump were capped and the sump was filled with cement on April 12, 1996 (Dow, 1997). The USEPA and NMED issued NODs (May 23, 1996, and September 4, 1996, respectively) related to the Phase II findings for this SWMU, both requiring additional investigation of the unit. In a letter dated January 31, 1997, WSMR maintained that additional investigation outside of that being conducted at surrounding SWMUs was not warranted (Ladd, 1997). WSMR also informed the USEPA and NMED of the 1997 closeout report for the SWMU 147 sump.

WSMR filed an NFA petition for the unit during January 2000 and June 2001. The petition was denied by NMED on March 11, 2002 because the unit required further investigation due to the detections of metals and organics during the Phase I and II RFIs (Frischkorn, 2002). The annual unit audits continue to list SWMU 147 as a unit requiring corrective action.

6.17.4 Investigative History

Phase I RFI

The Phase I RFI included collection of six soil samples from a 35-ft-bgs boring (147B1) and collection of a background soil sample. Samples were analyzed for VOCs, SVOCs, metals, and TPH.

Soil data collected from the background boring did not indicate any detectable constituents. Several constituents were detected in subsurface soils at SWMU 147, with the highest concentrations occurring between 15 and 30 ft bgs. Several VOCs, including acetone, carbon disulfide, 1,1-DCA, and BTEX were detected at concentrations below existing or proposed (in 1992) action levels. A notation on the table in the report indicated that acetone was introduced during sample collection.

Several SVOCs, including naphthalene, fluorene, phenanthrene, and BEHP were detected at concentrations below 1992 existing or proposed regulatory levels. Arsenic, barium, and lead were detected at concentrations below their respective 1992 action levels. Concentrations of TPH were detected and several of the detections exceeded 1992 New Mexico action levels. The two highest concentrations of TPH, 5,800 mg/kg and 13,000 mg/kg, occurred at 15 ft bgs and 25 ft bgs, respectively. The TPH concentration was much lower at 30 ft bgs at 190 mg/kg.

Based upon the results of the assessment, it was determined that a significant release had occurred in this area but that the detections could not be directly attributed to SWMU 147. The Phase I RFI concluded that the releases were related to SWMUs 142 and 154, and that they would be addressed under the SWMU 142 closure plan~~,~~ and RFI, and the SWMU 154 RFI and IRM. Based upon this condition, NFA was recommended for SWMU 147. However, NMED and the USEPA did not fully agree with the conclusions and recommendations for this SWMU. Phase II RFI activities were required in response to the regulators' comments.

Phase II RFI

A total of 45 soil samples from five soil boring locations were planned during the Phase II RFI; however, as a result of a field modification, none were collected. This was based upon the determination in the field that there was no underground waste tank at this location and that the proposed borings would be redundant with planned borings for other nearby SWMUs. SEI obtained historical drawings documenting that the suspect underground tank was actually an AST and the only remaining unit was the sump (i.e., the subsurface feature adjacent to the decontamination pad was actually a sump that discharged to an aboveground tank). Based upon this condition, it was determined that implementation of the proposed sampling plan was not necessary.

In lieu of the proposed plan, water and underlying sediment within the sump were collected for analyses. The water sample was analyzed for VOCs, SVOCs, and metals. The sediment sample was analyzed for VOCs, SVOCs, metals, TPH, and TCLP metals. At the time of the Phase II, the sump contained approximately 7.5 cubic feet (56 gallons) of sediment and 170 gallons of liquid.

Sample results indicated that concentrations of four VOCs were detected in the sump water sample. All four compounds (methylene chloride, 1,1,-DCE, 1,1-DCA, and 1,1,1-TCA) were detected at levels that exceeded their respective 1994 regulatory levels. One SVOC, BEHP, was detected above its regulatory level in the sump water sample. Only two inorganics (barium and lead) were detected in the sump water sample, and these detections were below their respective 1994 action levels.

Five VOCs (Methylene chloride, 1,1-DCA, MEK, 1,1-DCE, and 1,1,1-TCA) were detected in the sump sediment sample. Two of the compounds (1,1-DCE and 1,1,1-TCA) were detected above 1994 regulatory levels. The SVOC, BEHP, was detected above 1994 action levels. Concentrations of TPH were detected in sediment above 1994 land disposal action levels. Several metals were detected in the sump

sediment samples. Arsenic and silver were not detected. Barium, cadmium, mercury, and selenium were detected below their 1994 action levels. Concentrations of chromium and lead were detected above 1994 action levels. However, none of the metals were detected in the TCLP analysis.

The Phase II RFI report recommended that the SWMU undergo a CMS to determine the proper cleanup and disposal of the contaminated liquid and sediment, and the ultimate sump closure/removal.

The USEPA issued an NOD letter (Honker, 1995) that required information on whether the unit was active or inactive, the integrity of the sump, additional groundwater sampling for the vadose zone water and regional groundwater, and a CMS for determining proper closure and disposal requirement for the sump. The NMED also issued an NOD letter (Kelley, 1996) stating that the unit was not and must be adequately investigated.

Sump Closure

The contents of the sump (385 gallons of liquid and 825 pounds of solids) were removed on January 29, 1996, and disposed of offsite by incineration. On January 31, 1996, after the contents were removed, three soil borings were drilled through the floor of the sump and soil samples were collected from the upper 6 inches of soil underlying the sump. Soil samples were analyzed for TPH (DRO and GRO), VOCs, SVOCs, PCBs, and TCLP RCRA 8 metals. VOCs, SVOCs, TPH, and PCBs were not detected; however, the Phase II RFI Report stated the detection limits for VOCs were elevated. Maximum TCLP metals concentrations detected are as follows: barium (0.087 mg/L), lead (0.13 mg/L), selenium (0.079 mg/L), and silver (0.024 mg/L). Because the soils beneath the sump were determined to be nonhazardous, the decision was made to close the sump in place. The three inlet pipes to the sump were capped on February 2, 1996, and the vault was completely filled with concrete on April 12, 1996 (Dow, 1997).

Phase III RFI

There were no Phase III RFI activities proposed for SWMU 147 other than additional investigation of sump use and operational history. No additional information related to the unit's operational history was discovered during the Phase III RFI activities. Soil borings and associated data collected during the Phase III RFI conducted at nearby SWMU 142 (HELSTF Cleaning Facility Sump) and SWMU 154 (HELSTF Systemic

Diesel Spill) were be used to evaluate any potential releases associated with SWMU 147.

6.17.5 Nature and Extent of Contamination in Soil

In order to delineate the extent of soils affected by the decontamination pad and sump, a total of 14 soil samples from three soil boring locations collected during the RFI activities were evaluated (Figure 6.17-1). A table presenting all soil analytical data for the evaluation of this SWMU is presented in Table 6-1765 ~~of Appendix D-2~~.

6.17.5.1 ~~*Shallow Soil (0 to 10 ft bgs)*~~*VOCs*

6.17.5.1.1 Shallow Soil (0 to 10 ft bgs)~~Of the four samples collected from shallow soil (• 10 ft bgs), arsenic, BEHP, and TPH were detected. Table 6.17-1 provides a statistical summary of data for shallow soil and Table 6.17-2 provides a summary of exceedances of regulatory standards for shallow soil at SWMU 147.~~

~~6.17.5.1.2 VOCs~~

No VOCs were detected in shallow soils (• 10 ft bgs) at this unit.

6.17.5.1.2 Deep Soil (Greater than 10 ft bgs)

The only two VOCs detected above the DAF 20 criteria were benzene and ethylbenzene. Benzene was detected in only one sample (147B1, 25 ft bgs) and ethylbenzene was detected in only two samples (147 B1 (15 and 25 ft bgs) above the DAF 20 criteria. Neither of these VOCs were detected in shallower soils at this location. In addition, these VOCs were not detected in the 30 ft sample from this location; therefore, the benzene and ethylbenzene occurrences at 147B1 have been delineated vertically.

It should be noted that, since these VOCs were not detected in shallower soils, their occurrences in the deeper soils are not indicative of a release from SWMU 147, but are attributable to the underlying impacts from the release at SWMU 154. As stated previously, the areal extent of the diesel spill impacts extends to beneath SWMU 147.

6.17.5.2 *SVOCs*

6.17.5.2.1 Shallow Soil (0 to 10 ft bgs)

No SVOCs were detected in shallow soils (• 10 ft bgs) above the NMED SSL or DAF 20~~1~~.~~The only SVOC detected in shallow soils at this unit was BEHP. BEHP was detected in only one sample, 147B1 (5 ft bgs), at 0.46 mg/kg, which is well below the NMED SSL for residential soil (347 mg/kg) and the NMED DAF 1 screening level (1,070 mg/kg). BEHP is a common laboratory artifact and the detection is likely attributable to laboratory contamination. Additionally, it should be noted that this detection is isolated to one location (147B1). Due to these conditions, the detection is not being attributed to soil conditions at SWMU 147, and BEHP is not considered a COPC associated with this SWMU.~~

6.17.5.2.2 Deep Soil (Greater than 10 ft bgs)

The only SVOC that was detected above the DAF 20 criterion is naphthalene. Naphthalene was detected above the DAF 20 criterion in three samples from 147B1(15, 20, and 25 ft bgs). Naphthalene was not detected in shallower samples from this location. In addition, it was not detected in the 30 ft sample. Therefore, the naphthalene occurrence at location 147B1 has been delineated vertically.

It should be noted that, since naphthalene was not detected in shallower soils, its occurrences in the deeper soils are not indicative of a release from SWMU 147, but are attributable to the underlying impacts from the release at SWMU 154.

6.17.5.3 *Other Parameters*

6.17.5.3.1 Shallow Soil (0 to 10 ft bgs)

TPH were detected in shallow soil from 147B1 (5 ft bgs) and HCF-01 (4 to 6 ft bgs) at concentrations of 21 mg/kg and 2,600 mg/kg, respectively. No TPH were detected in the 10 ft bgs sample from 147B1 ~~or at the 2 ft bgs sample in 147BG~~. The elevated TPH concentrations at HCF-01 are attributable to releases from the Systemic Diesel Spill (SWMU 154).

6.17.5.3.2 Deep Soil (Greater than 10 ft bgs)

TPH were detected in deep soil from 147B1 as follows: 5,800 mg/kg (15 ft bgs), 960 mg/kg (20 ft bgs), 13,000 mg/kg (25 ft bgs), and 190 mg/kg (30 ft bgs). TPH were detected in deep soil from HCF-01 as follows: 5,200 mg/kg (30 ft bgs), 11,000 mg/kg (35 ft bgs), 2,200 (40 ft bgs), 1,600 (45 ft bgs), and 370 (60 to 70 ft bgs). Thus, the highest concentrations of TPH in the vicinity of SWMU 147 occur at depths of 25 to 35 ft bgs. The elevated TPH concentrations are associated with the release from SWMU 154 and are not attributable to releases from SWMU 147.

6.17.5.4 *Metals*

6.17.5.4.1 Shallow Soil (0 to 10 ft bgs)

There were no metals detected above the NMED SSL for residential soil in shallow soil at SMWU 147. With the exception of ~~A~~arsenic, which is attributable to redox-related conditions at the HELSTF, no other metals were detected above the DAF 20 criteria in shallow soil.

~~was the only metal detected in shallow soils, and it was detected in only one of the three shallow soil samples designated for this analysis at a concentration below the NMED SSL. As discussed in Section 4.3.6 (page 38), this detection of arsenic does not represent a release of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF that contained arsenic. The arsenic detection is attributable to naturally occurring conditions existing at the HELSTF and, therefore, is not considered a COPC associated with SWMU 147.~~

~~6.17.5.4.1~~6.17.5.4.2 Deep Soil (Greater than 10 ft bgs)

With the exception of the occurrences of arsenic that is being attributed to redox conditions and selenium~~,~~ that is being attributed to naturally occurring conditions~~which are attributable to redox-related conditions at the HELSTF~~, no other metals were detected above the DAF 20 criteria in deep soils at SWMU 147.

~~*Shallow*~~

~~6.17.5.5 *Soil Summary*~~

~~6.17.5.6 *In summary, no COPCs were detected in shallow soil at SWMU 147.*~~

~~6.17.5.7 *Deep Soil (Greater than 10 ft bgs)*~~

~~Table 6.17-3 provides a statistical summary of data for deep soil and Table 6.17-4 provides a summary of exceedances of regulatory standards for shallow soil at SWMU 147.~~

~~6.17.5.7.1 VOCs~~

~~VOC detections in deep soil (>10 ft bgs) at SWMU 147 included the following: 1,1-DCA, acetone, benzene, carbon disulfide, ethylbenzene, naphthalene, and total xylenes. None of these VOCs were detected in shallow soils at SWMU 147.~~

~~1,1-DCA was detected in one sample at a concentration of 0.00950 mg/kg, observed at 147B1 (25 ft bgs). The detection does not exceed the NMED DAF 1 screening value (0.339 mg/kg).~~

~~Acetone was detected in the soils deeper than 10 ft bgs at SWMU 147, below the DAF 1 (0.955 mg/kg) screening level. Acetone was detected at 147B1 at 0.120 mg/kg at 15 ft bgs, 0.520 mg/kg at 20 ft bgs, and at 0.600 mg/kg at 25 ft bgs. Acetone is a common laboratory artifact and the detections are likely attributable to laboratory contamination. Additionally, it should be noted that this acetone detection is isolated to one location (147B1). Due to these conditions, the detection is not being attributed to soil conditions at SWMU 147, and acetone is not considered a COPC associated with this SWMU.~~

~~Carbon disulfide was detected at 15 ft bgs at 147B1 at a concentration of 0.0065 mg/kg, which is below regulatory screening levels.~~

~~Benzene, ethylbenzene, naphthalene, and toluene were all detected in deep soils at 147B1 at concentrations exceeding their respective DAF 1 screening values. Benzene, ethylbenzene, naphthalene, and toluene (total) are not considered COPCs associated with SWMU 147 and are a result of releases at SWMU 154 (Systemic Diesel Spill). A discussion of the soils affected by the Systemic Diesel Spill is provided~~

in Section 6.25 (page 38). As discussed in Section 6.25 (page 38), the areal extent of the diesel fuel impacts in the subsurface currently includes the area beneath SWMU 147.

6.17.5.7.2 SVOCs

SVOC detections at SWMU 147 included fluorene and phenanthrene at 147B1. There were no SVOC exceedances of regulatory screening levels in deep soils (>10 ft bgs) at SWMU 147. The PAH occurrences in deep soils are attributable to the Systemic Diesel Spill (SWMU 154) and are not indicative of a release to the surface from SWMU 147. These PAHs were not detected in shallow soils at 147B1. As stated previously, the areal extent of the diesel impacts extends to beneath SWMU 147.

6.17.5.7.3 Other Parameters

TPH were detected in deep soil from 147B1 as follows: 5,800 mg/kg (15 ft bgs), 960 mg/kg (20 ft bgs), 13,000 mg/kg (25 ft bgs), and 190 mg/kg (30 ft bgs). TPH were detected in deep soil from HCF-01 as follows: 5,200 mg/kg (30 ft bgs), 11,000 mg/kg (35 ft bgs), 2,200 (40 ft bgs), 1,600 (45 ft bgs), and 370 (60 to 70 ft bgs). Thus, the highest concentrations of TPH in the vicinity of SWMU 147 occur at depths of 25 to 35 ft bgs. These elevated TPH concentrations at 147B1 are associated with the Systemic Diesel Spill (SWMU 154) and are not attributable to releases from SWMU 147.

6.17.5.7.4 Metals

Arsenic, barium, cadmium, chromium, lead, and selenium were detected in deep soils at SWMU 147. As described under Section 4.3.6 (page 38), arsenic, barium, and selenium detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 147.

Cadmium detections were observed at HCF-01 at depths of 19 to 20, 35, and 40 ft bgs. The maximum cadmium detection was 2.00 mg/kg, observed at 19 to 20 ft bgs. The detection at 19 ft bgs (2.0 mg/kg) exceeds the NMED DAF 1 screening value of 1.37 mg/kg. This cadmium exceedance of the NMED DAF 1 standard was an isolated occurrence in deep soils and was not detected in soils less than 10 ft bgs or in soils deeper soils than 40 ft bgs. This cadmium exceedance has been delineated. Because cadmium was not detected in shallow soils at this location, this exceedance can be attributed to the subsurface effects of the release from SWMU 142 underlying

~~SWMU 147. Therefore, cadmium is not considered a COPC associated with SWMU 147 and will be addressed as a COPC for SWMU 142.~~

~~Chromium detections were observed at HCF-01. The maximum chromium detection in deep soil was 5.0 mg/kg, at 19 to 20 ft bgs. There is no NMED DAF 1 screening level for chromium.~~

~~Lead detections were observed at 147B1 and HCF-01. The maximum lead detection in deep soil was 17.0 mg/kg, at HCF-01 (19 to 20 ft bgs). There is no NMED DAF 1 screening level for lead.~~

~~6.17.5.8~~6.17.5.5 ~~*Deep Soil*~~ *Summary*

In summary, any potential source at SWMU 147 was removed when closure of the sump was completed in 1996, and there were no reported releases from the unit. The unit was inactivated when the Cleaning Facility was inactivated in April 2009. Results of analyses for shallow soil samples collected beneath the floor of the sump prior to filling it with concrete did not indicate that there had been a release from the sump. All detections above regulatory levels at SWMU 147 occurred at depths greater than 10 ft bgs, which indicates that a release to soils above 10 feet at this location is not indicated. Impacts in soil greater than 10 ft bgs do not represent an exposure risk to human health or to ecological receptors.~~Cadmium is the only COPC detected above its NMED DAF 1 criterion. Vadose zone water samples collected from HCF-01 have had benzene, naphthalene, and 1-methylnaphthalene concentrations exceeding the regulatory standards. These are all COPCs associated with the Systemic Diesel Spill (SWMU 154) and are not related to releases from SWMU 147. Although cadmium was detected above the DAF 1 screening value in deep soil from HCF-01, cadmium has not been detected in vadose zone water samples collected from HCF-01 between 2004 and 2009 (Table 1 of Appendix D-3). The vadose zone water and downgradient regional groundwater in the area of the Cleaning Facility has known impacts from SWMU 142, the Cleaning Facility Sump, and SWMU 154, the Systemic Diesel Spill. Based on the soil data collected in the vicinity of SWMU 147, and knowledge of the operations at this unit, there is no indication that this unit contributed to those vadose zone water and regional groundwater impacts.~~

6.17.6 Human Health Risk Assessment Findings

Data collected during site characterization activities during the RFIs were used in the evaluation of risk to human health. A description of risk assessment methodologies and results is provided on page 212 of~~on page 201 of in~~ Appendix E.

The results of human health risk assessment data screening process indicate that after comparison to health-based soil screening levels for resident and site worker exposure, no COPCs were selected for surface soil at SWMU 147. In addition, the results of the data screening process also indicated that after comparison to health-based soil screening levels for construction worker exposure, no COPCs were selected for combined surface and subsurface soil at SWMU 147. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMU 147 are unlikely to result in adverse health impacts to the identified potential current and future receptors.

Additionally, no COPCs were selected for saturated vadose zone soil water, indicating that vapor intrusion from saturated vadose zone soil water is unlikely to result in adverse health impacts. However, nine volatile compounds in total soil were selected as COPCs for the vapor intrusion evaluation. As summarized in table E.14.HHRA-11, the findings of the vapor intrusion evaluation indicate that potential future industrial or residential development of the site would result in potential indoor air exposures that are below the regulatory benchmarks for cancer risks and non-cancer hazards. Based on these results, additional human health risk assessment is not warranted for SWMU 147.

~~6.17.6.1 *Soil Exposure Scenarios*~~

~~In accordance with NMED guidance (NMED, 2006a), constituent concentrations in surface soil and in combined surface and subsurface soil were compared to health-based screening levels and the calculated ratios summed. The total ratios were less than the NMED target ratio of 1. The results of this data screening process indicate that after comparison to health-based SSLs for industrial worker exposure, residential exposure, and construction worker exposure, no COPCs were selected for surface soil or for combined surface and subsurface soil at SWMU 147. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMU 147 are unlikely to result in adverse health impacts to the following potential receptors via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, dermal):~~

- Current and future site workers;
- Future residents (adults and children); and
- Future construction workers.

6.17.6.2 *Vapor Intrusion Scenarios*

All detected VOCs in total soil (i.e., vadose zone) were selected as COPCs for the future vapor intrusion evaluation because there are no NMED or USEPA SSLs that are protective of the vapor intrusion pathway. The total ELCR values for the future vapor intrusion exposure pathway for the site worker scenario and for the residential scenario are within the target risk range of 10^{-6} to 10^{-4} for carcinogenic effects. The total HI value for the future vapor intrusion exposure pathway for the site worker scenario is below the benchmark of 1 for non-cancer hazard. The total HI value for the future vapor intrusion exposure pathway for the hypothetical future child resident is slightly above the benchmark of 1. When the HI for a hypothetical future child resident exposure to indoor air is segregated into target organ site and critical effects, the HI for nasal and lung was 2, which is above the benchmark of 1. The primary risk driver for the future residential exposure scenario was naphthalene in 147B1 which, as discussed previously, is associated with the Systemic Diesel Spill (SWMU 154) and is not attributable to releases from SWMU 147.

All detected volatile constituents in saturated vadose zone water were compared to the USEPA (2002a) groundwater screening levels for the protection of human health via vapor intrusion, and the calculated ratios summed. The total ratios were below the NMED target ratio of 1. The results of this data screening process indicate that after comparison to health-based groundwater screening levels, no COPCs were selected for saturated vadose zone water at SWMU 147. This demonstrates that the constituent concentrations in saturated vadose zone water at SWMU 147 are unlikely to result in adverse health impacts to future industrial worker and hypothetical future residents through vapor migration into indoor air.

6.17.6.3 *Overall HHRA Summary*

The results of this data screening process indicate that after comparison to health-based SSLs for resident and site worker exposure, no COPCs were selected for surface soil at SWMU 147. In addition, the results of the data screening process also indicated that after comparison to health-based SSLs for construction worker exposure,

~~no COPCs were selected for combined surface and subsurface soil at SWMU 147. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMU 147 are unlikely to result in adverse health impacts to the identified potential current and future receptors.~~

~~Additionally, no COPCs were selected for saturated vadose zone water, indicating that vapor intrusion from saturated vadose zone water is unlikely to result in adverse health impacts. However, nine volatile compounds in total soil were selected as COPCs for the vapor intrusion evaluation. The findings of the vapor intrusion evaluation indicated that:~~

- ~~Under hypothetical future conditions, the ELCR and HI are within or below acceptable target risk ranges for site worker exposure to indoor air containing VOCs originating from total soil (i.e., vadose zone); and~~
- ~~Under hypothetical future conditions, the ELCR was within the acceptable target risk range for resident exposure to indoor air containing VOCs originating from total soil (i.e., vadose zone). However, the non-cancer HI was above the acceptable benchmark of 1 due to naphthalene detected in two samples.~~

~~It is important to reiterate that the scenario for which the unacceptable hazard was calculated is a hypothetical future scenario. There are no unacceptable risks and/or hazards to current receptors (i.e., site workers) at SWMU 147. In addition, as discussed in the HHRA of Appendix E, the unacceptable hazard was calculated for an extremely unlikely future scenario using highly conservative exposure assumptions. Therefore, the potential for COPCs at SWMU 147 to represent a significant concern in the future is considered low, and additional evaluation is considered unnecessary. Further, the presence of naphthalene is attributable to the Systemic Diesel Spill (SWMU 154) and not to a release from SWMU 147.~~

6.17.7 Ecological Risk Assessment Findings

As described within the ERA presented ~~in~~ on page 214 of ~~on page 204 of~~ Appendix E, a SLERA and BERA were completed for SWMU 147. After the SLERA, one constituent (BEHP) was selected as a COPEC in combined surface and subsurface soil because the HQ was greater than 1. However, the only sample reporting a detected concentration of BEHP was collected from a depth of 5 ft bgs, limiting potential exposure to only burrowing animals. In addition, the refined HQ is only slightly above 1 (i.e., 5) and is based on a conservative USEPA Region 4 ESL for total

phthalates. When an alternative ESL of 0.925 mg/kg was obtained for BEHP from USEPA Region 5 (2003d), a refined HQ less than 1 was calculated.

Based on this information, adverse impacts are not expected for terrestrial wildlife potentially exposed to BEHP in subsurface soil at SWMU 147.

6.17.8 Conclusions and Recommendations

There were no reported releases from SWMU 147. This unit has not been in use since before 1996, with any potential source at SWMU 147 eliminated when the sump was closed. Soil samples collected through the floor of the sump after its contents were emptied did not contain any constituent detections indicative of a release from the sump. The vadose zone water and downgradient regional groundwater in the area of the Cleaning Facility has known impacts from SWMU 142, the Cleaning Facility Sump, and SWMU 154, the Systemic Diesel Spill. Based on the soil data collected in the vicinity of SWMU 147, there is no indication that this unit contributed to those vadose zone water and regional groundwater impacts.

The results of the human health risk assessment data screening process indicate that after comparison to health-based soil screening levels for resident and site worker exposure, no COPCs were selected for surface soil at SWMU 147. In addition, the results of the data screening process also indicated that after comparison to health based soil screening levels for construction worker exposure, no COPCs were selected for combined surface and subsurface soil at SWMU 147. This demonstrates that the constituent concentrations in surface soil and combined surface and subsurface soil at SWMU 147 are unlikely to result in adverse health impacts to the identified potential current and future receptors.

Additionally, no COPCs were selected for saturated vadose zone soil water, indicating that vapor intrusion from saturated vadose zone soil water is unlikely to result in adverse health impacts. However, nine volatile compounds in total soil were selected as COPCs for the vapor intrusion evaluation. The findings of the vapor intrusion evaluation indicated that:

- Under hypothetical future conditions, the ELCR and HI are within or below acceptable target ranges for site worker and resident exposure to indoor air containing VOCs originating from total soil (i.e., vadose zone).

A SLERA and BERA were completed for SWMU 147 to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents detected in subsurface soil. The results of the SLERA and BERA for direct contact exposure indicate there is adequate information to conclude that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in soil. Therefore, no further ecological evaluation at SWMU 147 is warranted.

There are no adverse environmental impacts associated with SWMU 147 as a result of historical site activities and no restrictions need to be applied to current or potential future land use at the site. Accordingly, the site is recommended for no further action and should be closed out of the RCRA process.

~~The results of this data screening process for the HHRA indicate that, after comparison to health-based soil screening levels for resident and site worker exposure, no COPCs were selected for surface soil at SWMU 147. In addition, the results of the data screening process also indicated that after comparison to health-based SSLs for construction worker exposure, no COPCs were selected for combined surface and subsurface soil at SWMU 147. This demonstrates that the constituent concentrations in surface soil and combined surface and subsurface soil at SWMU 147 are unlikely to result in adverse health impacts to the identified potential current and future receptors.~~

~~Additionally, no COPCs were selected for saturated vadose zone soil water, indicating that vapor intrusion from saturated vadose zone soil water is unlikely to result in adverse health impacts. However, nine volatile compounds in total soil were selected as COPCs for the vapor intrusion evaluation. The findings of the vapor intrusion evaluation indicated that:~~

- ~~Under hypothetical future conditions, the ELCR and HI are within or below acceptable target risk ranges for site worker exposure to indoor air containing VOCs originating from total soil (i.e., vadose zone); and~~

- ~~Under hypothetical future conditions, the ELCR was within the acceptable target risk range for resident exposure to indoor air containing VOCs originating from total soil (i.e., vadose zone). However, the non-cancer HI was above the acceptable benchmark of 1, primarily due to naphthalene detected in samples collected at depths greater than 15 ft bgs. After further examination of naphthalene at SWMU 147, the potential for the site to represent a significant concern via the vapor intrusion pathway in the future is considered low, and additional evaluation is~~

~~considered unnecessary. Further, the presence of naphthalene is attributable to the Systemic Diesel Spill (SWMU 154).~~

~~A SLERA and BERA were completed for SWMU 147 to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents detected in subsurface soil. The results of the SLERA and BERA for direct contact exposure indicate there is adequate information to conclude that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in soil. Therefore, no further ecological evaluation at SWMU 147 is warranted.~~

~~There are no current environmental impacts associated with SWMU 147 as a result of historical site activities. Based on data collected from nearby soil borings and during the closure of the sump at SWMU 147, impacts to vadose zone water in this area are not attributable to SWMU 147. Although the risk assessment indicated that potential future residential development of the site may result in potential indoor air exposures that are above the regulatory benchmark for non-cancer hazards if all exposure assumptions are met, these potential exposures are based on naphthalene concentrations in saturated soil in the vadose zone, which have been impacted by SWMU 154. In addition, it is important to reiterate that the scenarios for which unacceptable risks and/or hazards were calculated are all hypothetical future scenarios. There are no unacceptable risks and/or hazards to current receptors (i.e., site workers) at SWMU 147. Accordingly, the site is recommended for NFA and should be closed out of the RCRA process.~~

6.18 SWMU 148 – Former ~~Multifunction Array Radar~~ MAR Waste Stabilization Pond (WSMR-83)

6.18.1 Unit Description

The Former MAR Waste Stabilization Pond consisted of an unlined pond with an earthen berm that was used to treat sewage effluent and possibly industrial wastewater generated by the former MAR facilities. The unit was 110 feet by 130 feet and 7 feet deep, and is located beneath the south end of the current HELSTF Equipment Storage Area (SWMU 141). The pond was filled in and graded in 1981 (precise dates of use and subsequent backfilling are unknown). The overlying Equipment Storage Area was paved in 1990. The COPCs associated with SWMU 148 are those associated with sanitary sewage and industrial wastewater.

6.18.2 Operational History

The Former MAR Waste Stabilization Pond was constructed in 1962. During 1981, the unit was backfilled and graded during the construction of the existing HELSTF facilities. A new Sanitary Treatment System (SWMUs 27-30) was constructed as a replacement.

6.18.3 Regulatory History

The MAR Waste Stabilization Pond was not identified in either of the two RFAs that were prepared during 1988. Therefore, the unit was not included in the initial RCRA HSWA Permit issued on October 24, 1989. The former waste pond was first identified after the discovery of a Chromiumate Spill (SWMU 143) in the same area during December 1989 (Hayslett, 1990a).

The USAEHA conducted an evaluation of environmental conditions at the HELSTF in July 1990. The regulatory agencies were notified of the discovery of SWMU 148 in a report entitled Ground-water Quality Survey No. 38-26-0368-90, *High Energy Laser Systems Test Facility, White Sands Missile Range, New Mexico, 23-27 July 1990*. On August 7, 1991, the USEPA approved the addition of SWMU 148 as an Appendix IV site requiring investigation. SWMU 148 is listed on the current (2009) facility permit as a SWMU requiring corrective action (NMED, 2009).

As further described under Section 6.18.7 (Investigative History, page 295), assessment of SWMU 148 was conducted during the Phase I RFI. Arsenic, lead, and barium were detected in soil at background concentrations (background based on the results of background soil samples collected during the Phase I RFI). Chromium, hexavalent chromium, and two organics were detected in water from the newly installed Vadose Zone Well HMW-11 at concentrations exceeding 1992 regulatory standards. However, in the Phase I RFI Report, the source of impacts was attributed to the release that occurred at SWMU 143 and it was recommended that the RFI for SWMU 148 be discontinued. On January 23, 1993, NMED concurred with the recommendations in the Phase I RFI provided that WSMR would commit to an ongoing program of groundwater monitoring at the HELSTF area (Morgan, 1993a). The USEPA did not agree with the conclusions of the Phase I RFI report and requested that further source characterization be performed in the Phase II RFI for SWMU 148 (Honker, 1993).

As further described under Section 6.18.7 (page 295), a Phase II RFI assessment of the SWMU was conducted. Soil data indicated very low concentrations of three VOCs

(i.e., significantly below their respective 1994 action levels) in several soil samples. Five metals were detected in soil samples at concentrations below their respective 1994 action levels. The Phase II RFI Report concluded that the Phase I and Phase II RFIs provided no evidence of a release from SWMU 148.

During 1996, both USEPA and NMED issued notices of deficiencies related to the~~is~~ SWMU. The USEPA recommended that the unit be closed in accordance with surface impoundment or landfill closure requirements. This would include conducting post closure validation that would demonstrate that clean closure of the unit had been achieved, or conducting post closure care and associated groundwater monitoring if the unit cannot be clean closed. The NMED requested that additional assessment of subsurface conditions beneath the fill material used to backfill the unit be conducted as part of a Phase III RFI.

6.18.4 Investigative History

~~A summary of monitoring points~~ The soil sampling locations used to investigate SWMU 148 ~~is provided~~ are shown on Figure 6.18-1~~7~~ and the analytical data for soil ~~samples~~ used to evaluate this SWMU are provided in Table 6.18-18~~16 of Appendix D-2~~. Descriptions of assessments are provided below.

Phase I RFI

As part of the Phase I RFI, a background soil sample (148BG1) was collected from ~~two~~2 ft bgs , six soil samples (10, 20, 25, 30, duplicate of 30, and 37 ft bgs) were collected during the installation of Vadose Zone Monitoring Well HMW-11, and a subsequent groundwater sample was collected from HMW-11 after the well was completed. Samples were analyzed for VOCs, SVOCs, metals, and TPH; the groundwater sample was also analyzed for hexavalent chromium. A greenish-yellow tint was noticed in development water from HMW-11.

There were no detected constituents in the background sample 148BG1. Trace concentrations of total chromium and arsenic were detected in the background samples 143BG1 and 141BG1, respectively. The three background samples were collected to address background soil conditions for SWMUs 141, 143, and 148. Soil data indicated detections of lead, barium, and arsenic at background levels at HMW-11. The metals concentrations were also below the 1992 proposed regulatory standards.

Total chromium, hexavalent chromium, 1,1-DCE, and TCE were detected in vadose zone water from HMW-11 at concentrations exceeding 1992 action levels. Selenium was also detected in vadose zone water from HMW-11. The chromium and hexavalent chromium in vadose zone water were attributed to SWMU 143 and the two organics were attributed to an unknown source because soil samples above the transmissive zone did not have detections of those organic constituents. It was recommended that the RFI for SWMU 148 be discontinued because SWMU 143 would be investigated extensively. However, the NMED and USEPA both required further investigation of SMWU 148 in their respective NOD letters for the Phase I RFI.

Phase II RFI

As part of the Phase II RFI, nine soil borings (148SB01 through 148SB09) were advanced to 10 ft bgs with samples collected at approximate 5-foot intervals (0-1, 4-5, and 9-10 ft bgs from each boring), totaling 27 soil samples. Soil samples were analyzed for VOCs, SVOCs, metals, and hexavalent chromium. Soil data indicated that three VOCs (methylene chloride, 1,1-DCE, and acetone) were detected at concentrations just above their respective quantitation limits and well below their 1994 action levels. Methylene chloride was detected in the laboratory blank as well. One SVOC, di-n-butylphthalate, was also detected just above its quantitation limit and well below the 1994 action level. Five metals (arsenic, barium, lead, mercury, and silver) were detected in soil at concentrations below action levels. Hexavalent chromium was not detected in any of the soil samples.

The Phase II RFI report stated that, based upon the results of the Phase I and Phase II RFIs, there was no evidence of a release from SWMU 148. It was recommended that the RFI process be discontinued for SWMU 148. However, the EPA required that the unit undergo regulatory closure and the NMED required additional sampling through the fill inside the unit to assess native soils beneath the fill.

Phase III RFI

As part of the Phase III RFI, two soil borings (HLSF-SB-025 and HLSF-SB-027) were advanced to a depth of 50 ft bgs to identify the elevation of the former impoundment bottom and to collect soil samples for analyses. These soil borings were advanced in conjunction with those borings advanced for SWMU 143 (HLSF-SB-022 through HLSF-SB-024, HLSF-SB-026, and HLSF-SB-028) and for SWMU 141 (HLSF-SB-037 through HLSF-SB-039). Soil samples for SWMUs 143 and 148 were analyzed for nitrate-nitrite as N, phosphorus, hexavalent chromium, RCRA 8 metals, copper,

sodium, zinc, ethylene glycol, alcohols, VOCs, SVOCs, TPH-GRO, TPH-DRO, and TOC. The soil samples for SWMU 141 were analyzed for the eight RCRA metals, VOCS, TPH-GRO, and TPH-DRO.

Groundwater samples were collected from eight existing monitoring wells situated in close proximity to the SWMU as part of the assessment: seven vadose zone monitoring wells (DRW-09, DRW-10, HMW-12, HMW-39, HMW-40, HMW-41, and HMW-43) and one regional groundwater monitoring well (DRW-14) (Figure 4.3-~~9~~10). Groundwater samples were analyzed for water quality parameters, ammonia-nitrogen, dissolved ions, phosphorus, hexavalent chromium, cadmium, total chromium, copper, lead, silver, sodium, zinc, alcohols, VOCs, and TOC. Due to the proximity of the groundwater wells to the Systemic Diesel Spill at SWMU 154, the samples were also analyzed for TPH-DRO and TPH-GRO.

The 2006 Phase III RFI report indicated that arsenic was the only inorganic constituent detected above its NMED SSL for residential soil. However, none of these exceedances occurred in the upper 10 feet and, therefore, arsenic would no longer be addressed as a COPC. Although chromium was detected above the background concentration developed in the 2006 Phase III RFI report, it was not detected above the NMED SSL for residential soil. The only organic detected was di-n-octylphthalate, which was detected in two soil samples at concentrations below the regulatory screening level.

The 2006 Phase III RFI report indicated that groundwater from Vadose Zone Wells HMW-39, located approximately 100 ft northeast of SWMU 148, and HMW-41, located approximately 50 ft east of the SWMU, had detectable concentrations of chlorinated solvents from an unknown source. The report stated that the occurrence of these constituents would be further assessed if the vadose zone water d~~oes~~id not dissipate after the sewage lagoons (SWMU 27) ~~a~~were removed from service. Groundwater from Regional Well DRW-14, located approximately 200 ft east of SWMU 148, had elevated levels of many constituents, including nitrate and chromium. In addition, the report indicated that, due to the presence of chromium in the vadose zone water, the Chromium Spill Area (SWMU 143) would be addressed in the CMS.

The 2006 Phase III RFI report concluded that the only COPC for the Central Storage Zone (including SWMU 148) was chromium. The report also stated that the regional groundwater at DRW-14 was impacted by drainage from the vadose zone.

6.18.5 Nature and Extent of Contamination

The Phase III RFI Work Plan (WTS, 2006) identified the potential contaminants associated with the former MAR Stabilization Pond (SWMU 148) as sewage, cooling water, detergents, and solvents. Results of soil samples collected within and surrounding SWMU 148 were used to delineate affected soil. In addition, several soil sampling locations installed ~~with~~for the purpose of delineating impacts at nearby SWMUs (i.e., SWMUs 141 and 143) were located within or near SWMU 148 and were used in the nature and extent analysis herein.

The soil boring locations are shown on Figure 6.18-1~~7~~, and a comprehensive data summary for soil is provided in Table 6-18~~.1 16 of Appendix D-2~~.

6.18.5.1 ~~*Shallow Soil (0 to 10 ft bgs)*~~*VOCs*~~*Table 6.18-1 provides a statistical summary of data for shallow soil and Table 6.18-2 provides a summary of exceedances of regulatory standards for shallow soil at SWMU 148.*~~

6.18.5.1.1 ~~VOCs~~Shallow Soil (0 to 10 ft bgs)

No VOCs were detected in shallow soil at SWMU 148 above the NMED SSLs for residential soil or above the DAF 20 criteria.~~Acetone and methylene chloride were the only VOCs detected in shallow soil (• 10 ft bgs) at SWMU 148. Methylene chloride and acetone were each detected in four shallow soil samples. All of the methylene chloride results were flagged with a "B", indicating that it was detected in the laboratory blank as well. Therefore, methylene chloride is considered a laboratory contaminant and is not considered a COPC for SWMU 148. Acetone is also a common laboratory artifact and the detection is likely attributable to laboratory contamination. Additionally, it should be noted that this acetone detection is isolated to only a few samples collected at this SWMU. Therefore, the acetone detection is not attributed to soil conditions at SWMU 148, and acetone is not considered a COPC associated with this SWMU.~~

6.18.5.1.2 Deep Soil (Greater than 10 ft bgs)

No VOCs were detected above the DAF 20 criteria in deep soil at SWMU 148.

6.18.5.2 *SVOCs*

6.18.5.2.1 Shallow Soil (0 to 10 ft bgs)

No SVOCs were detected above the NMED SSLs for residential soil or above the DAF 20 criteria in shallow soil at SWMU 148.

6.18.5.2.2 Deep Soil (Greater than 10 ft bgs)

No SVOCs were detected above the DAF 20 criteria in deep soil at SWMU 148.~~One SVOC, di-n-butylphthalate, was detected in shallow soil (• 10 ft bgs) at SWMU 148. The detection occurred at a depth of 8 feet at 148-SB-02, at a concentration well below its NMED SSL for residential soil and its NMED DAF 1 value. Phthalates are common laboratory artifacts and this detection is likely attributable to laboratory contamination. Additionally, it should be noted that this detection is isolated to one sample collected at this SWMU and was delineated. The di-n-butylphthalate detection is not attributed to soil conditions at SWMU 148, and it is not considered a COPC associated with this SWMU.~~

6.18.5.3 *Metals*

6.18.5.3.1 Shallow Soil (0 to 10 ft bgs)

With the exception of arsenic, which is attributable to redox-related conditions at the HELSTF, no metals were detected above the NMED SSLs for residential soil in shallow soil at SWMU 148. Arsenic and silver were the only metals detected at concentrations exceeding the DAF 20 criteria in shallow soil at SMWU 148.

~~In soil samples collected from the upper 10 feet, arsenic, barium, chromium, lead, mercury, and silver were detected above laboratory reporting limits. Arsenic was detected in 17 of 37 shallow soil samples and barium was detected in 30 of 37 shallow soil samples designated for these analyses at SWMU 148. As described under Section 4.3.6 (page 38), arsenic and barium detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 148.~~

~~Chromium was detected in 2 of the 38 shallow soil samples, lead was detected in 15 of 37 shallow soil samples, and mercury was detected in 3 of the 37 shallow soil samples designated for these analyses. None of these metals were detected above their~~

~~respective NMED SSLs, and none of the mercury concentrations exceeded the DAF 1 screening values in shallow soils at SWMU 148. There are no DAF 1 screening values for chromium or lead.~~

Silver was detected in 12 of the 37 shallow soils designated for this analysis. None of the silver detections exceeded the NMED SSL of 391 mg/kg. Silver was detected at concentrations above the NMED DAF ~~1~~20 screening value of ~~1.57~~31.3 mg/kg in shallow soil at SWMU 148 as follows: at ~~HMW-43 (1, 3, and 9 ft bgs),~~ SWMU 148 SB-01(8 ft bgs), SWMU 148 SB-02 (4 and 8 ft bgs), SWMU 148 SB-03 (4 and 8 ft bgs), SWMU 148 SB-04 (1 ft bgs), SWMU 148 SB-05 (9 ft bgs), SWMU 148 SB-06 (1 ft bgs), and SWMU 148 SB-08 (1 ft bgs). ~~The detections did not exceed the NMED SSL of 391 mg/kg. The maximum detection of silver was 74.8 mg/kg at SWMU 148 SB-03 (depth of 8 ft bgs).~~ The occurrences of silver at SWMU 148 are shown on Figure 6.18-2. Silver exceedances of the DAF 20 in shallow soil have generally been delineated in this area, as shown on Figure G-2 in Appendix G ~~-2on Figure G-21 in Appendix G~~. Silver is not an identified COPC associated with SWMU 148, but it has been retained for evaluation.

6.18.5.3.2 Deep Soil (Greater than 10 ft bgs)

With the exception of arsenic, which is attributable to redox-related conditions at the HELSTF, none of the metals were detected above the DAF 20 in deep soil at SWMU 148.

6.18.5.4 *Summary*

~~6.18.5.3.1~~ The depth to water in the vadose zone in the vicinity of this SWMU is approximately 40 to 45 ft bgs. Silver, which was detected in shallow soil at SWMU 148 above the DAF 20 criterion, has not been detected in vadose zone water during the past 5 years at Wells HMW-11, HMW-43, DRW-09, DRW-10, HMW-37, HMW-38, HMW-39, or HMW-41. In addition, no silver detections above regulatory standards have occurred in downgradient regional groundwater Wells HMW-16, HMW-58, or HMW-63.~~Shallow Soil Summary~~

~~In summary, no COPCs were detected above NMED SSLs in shallow soils at SWMU 148. Silver was the only constituent detected in shallow soils at SWMU 148 above a regulatory standard (i.e., the DAF 1 screening value). The occurrences of silver at SWMU 148 are shown on Figure 6.18-2.~~

~~6.18.5.4 *Deep Soil (Greater than 10 ft bgs)*~~

~~6.18.5.4.1 Soil samples were collected from depths greater than 10 ft bgs from the following borings at SWMU 148: HLSF-SB-024 through HLSF-SB-027, HMW-11, and HMW-43.One VOC (TCE), one SVOC (di-n-butylphthalate), and seven metals (arsenic, barium, chromium, copper, lead, silver, and zinc) were detected in deep soils from SWMU 148. Table 6.18-3 provides a statistical summary of data for deep soil and Table 6.18-4 provides a summary of exceedances of regulatory standards for deep soil at SWMU 148. VOCs~~

~~TCE was the only VOC detected in deep soils. TCE was detected in only 1 of the 46 deep soil samples designated for this analysis, HMW-43 (59 ft bgs), at a concentration of 0.0403 mg/kg, which exceeds the NMED DAF 1 screening value of 0.0001 mg/kg (Figure 6.18-3). This exceedance of the NMED DAF 1 is isolated to this location and has been delineated laterally. Because TCE was not detected in shallow soils at HMW-43, the TCE exceedance of the DAF 1 standard at 59 ft bgs is not the result of a release from an overlying source area. The depth to the water in HMW-43 is approximately 43 ft bgs. Thus, the exceedance of TCE occurs in saturated soil. Therefore, the TCE exceedance has been delineated vertically within the soil column at HMW-43. It should be noted that TCE has not been detected in vadose zone water from HMW-43.~~

~~6.18.5.4.2 SVOCs~~

~~One SVOC, di-n-octylphthalate, was detected in deep soil (>10 ft bgs) at SWMU 148. It was detected at 0.313 mg/kg at HLSF-SB-024 (40-41 ft bgs). There are no NMED SSL or DAF 1 standards for this constituent. Di-n-octylphthalate was not detected in shallow soils at this location and its occurrence in this sample is not indicative of a release from SWMU 148. The occurrence of this SVOC is isolated to this location and it is, therefore, considered delineated. In addition, phthalates are common laboratory artifacts and this detection is likely attributable to laboratory contamination. Di-n-octylphthalate is not a COPC associated with this SWMU.~~

~~6.18.5.4.3 Metals~~

~~Arsenic was detected in 13 of the 27 deep soil samples and barium was detected in 25 of the 27 deep soil samples designated for these analyses at SWMU 148. As described under Section 4.3.6 (page 38), arsenic and barium detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 148.~~

There were two detections of silver in the deep soil at HMW-43 (18 ft bgs and 38 ft bgs), which both exceeded the NMED DAF 1 screening value of 1.57 mg/kg. Silver was detected in shallower soils at this location as well. The silver DAF 1 exceedances at HMW-43 have been delineated vertically and laterally in the area of SWMU 148. Silver is not a known COPC for SWMU 148, but has been retained for evaluation. General delineation of silver in deep soils at the HELSTF is shown on Figure G-2 in Appendix G.

Chromium, copper, lead, and zinc were detected in deep soils at SWMU 148. None of the copper and zinc detections exceeded their respective DAF 1 screening levels. There are no DAF 1 screening values for chromium or lead.

6.18.5.4.4 Deep Soil Summary

The depth to water in the vadose zone in the vicinity of this SWMU is approximately 40 to 43 ft bgs. Silver, which was detected in shallow and deep soils at SWMU 148 at concentrations above the DAF 1 screening value, has not been detected in vadose zone water during the past 4 years at Wells HMW-11, HMW-43, DRW-09, DRW-10, HMW-37, HMW-38, HMW-39, or HMW-41. Although TCE has been detected in vadose zone water from HMW-11, HMW-38, HMW-39, and HMW-41, it has not been detected in vadose zone water from HMW-43 where the TCE exceedance of the DAF 1 standard occurred. In addition, no silver or TCE detections above regulatory standards have occurred in downgradient regional groundwater Wells HMW-52 or HMW-63. Section 6.25 (page 38) provides discussion regarding the source of TCE detected in nearby vadose zone water monitoring wells.

6.18.6 Human Health Risk Assessment Findings

Data collected during site characterization activities during the RFIs were used in the evaluation of risk to human health. A description of risk assessment methodologies and results is provided on page 228 of~~on page 215 of in~~ Appendix E.

6.18.6.1 *Soil Exposure Scenarios*

In accordance with NMED guidance (NMED, 2006a), constituent concentrations in surface soil and in combined surface and subsurface soil were compared to health-based screening levels and the calculated ratios summed. The total ratios were less than the NMED target ratio of 1. The results of this data screening process indicate that after comparison to health based SSLs for industrial worker exposure, residential

~~exposure, and construction worker exposure, no COPCs were selected for surface soil or for combined surface and subsurface soil at SWMU 148. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMU 148 are unlikely to result in adverse health impacts to the following potential receptors via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, dermal):~~

- ~~Current and future site workers;~~
- ~~Future residents (adults and children); and~~
- ~~Future construction workers.~~

~~6.18.6.2 *Vapor Intrusion Scenarios*~~

~~No VOCs were detected in total soil (i.e., vadose zone). Therefore, no soil COPCs were identified for the future vapor intrusion evaluation at SWMU 148. However, there were four VOCs detected in shallow saturated vadose zone water. All detected VOCs in saturated vadose zone water were compared to the USEPA (2002) groundwater screening values that are protective of the vapor intrusion pathway. As summarized in Table E.15.HHRA-13 of Appendix E, the total ELCR values for the future vapor intrusion exposure pathway for the site worker scenario and for the residential scenario are below the acceptable target risk range of 10^{-6} to 10^{-4} for cancer effects. The total HI values for the future vapor intrusion exposure pathway for the site worker scenario and for the residential scenario are below the benchmark of 1 for non-cancer hazard, indicating adverse non-cancer effects are unlikely to occur.~~

~~6.18.6.3 *Overall HHRA Summary*~~

The results of the data screening process indicate that, after comparison to health-based soil screening levels for industrial worker exposure, residential exposure, and construction worker exposure, no COPCs were selected for surface soil, or for combined surface and subsurface soil at SWMU 148. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMU 148 are unlikely to result in adverse health impacts to the identified current and potential future receptors. Additionally, no VOCs were selected as COPCs in soil, indicating that vapor intrusion from soil is unlikely to represent an exposure concern. However, four VOCs in the saturated vadose zone water were selected as COPCs for the vapor intrusion evaluation. The findings of the vapor intrusion evaluation indicate that potential future industrial or residential development of the site would result in

potential indoor air exposures that are below the regulatory benchmarks for cancer risks and non-cancer hazards. Based on these results, additional HHRA is not warranted for SWMU 148.

6.18.7 Ecological Risk Assessment Findings

~~6.18.7.1 *Ecological Risk Summary*~~

As described within the ERA presented on page 227 o~~f on page 216 of in~~ Appendix E, screening level and baseline risk assessments were completed for SWMU 148. After the SLERA, one constituent (i.e., silver) was selected as a COPEC in surface soil and in combined surface and subsurface soil because the HQs were greater than 1. In the BERA, silver was retained for further evaluation in the food chain modeling because it was identified as bioaccumulative.

Tables E.15.ERA-20 and E.15.ERA-21 of Appendix E summarize the constituents in surface soil and in combined surface and subsurface soil that were carried through the BERA and evaluated in the terrestrial food chain model. As shown in these tables, all receptors evaluated in the terrestrial food chain refined scenarios had LOAEL and NOAEL HQs less than or equal to 1 with the exception of the desert shrew which had a refined HQ slightly above 1. However, the affected area of silver with refined HQs greater than 1 for the desert shrew has a very limited spatial extent (less than 0.3 acre). Based on the overall analysis of the ERA for SWMU 148, the results indicate that if exposure were to occur, then population-level adverse effects are not expected for wildlife that may access the site.

It is important to reiterate here that the above assessment is for a hypothetical future scenario and only applies if the site was redeveloped and the asphalt covering removed. There are no ecologically significant current risks at SWMU 148 because:

- The site is currently covered by asphalt which eliminates the exposure pathway for wildlife via a physical barrier; and
- The affected area is very limited in spatial extent (less than 0.3 acre). Therefore, any exposure by terrestrial wildlife is not expected to cause adverse population-level impacts to exposed receptors.

6.18.8 Conclusions and Recommendations

Silver ~~and TCE were~~ was the only constituent~~s~~ detected in soil above ~~their respective~~ regulatory screening levels. None of the silver concentrations detected exceeded the NMED SSL for residential soil, and nine of the detections exceeded the DAF 20 criterion. The occurrences of silver in the vicinity of SWMU 148 have been delineated. Silver is not a known COPC associated with SWMU 148 and it has not been detected in vadose zone water or downgradient regional groundwater at or near SWMU 148. ~~TCE occurred at only one isolated location, and was not detected in vadose zone water at that location.~~ None of the soil exceedances are indicative of releases from SWMU 148.

~~No VOCs were detected in total soil (i.e., vadose zone). Therefore, no soil COPCs were identified for the future vapor intrusion evaluation at SWMU 148. However, there were four VOCs detected in shallow saturated vadose zone water. All detected VOCs in saturated vadose zone water were compared to the USEPA (2002) groundwater screening values that are protective of the vapor intrusion pathway. The total ELCR values for the future vapor intrusion exposure pathway for the site worker scenario and for the residential scenario are below the acceptable target risk range of 10^{-6} to 10^{-4} for cancer effects. The total HI values for the future vapor intrusion exposure pathway for the site worker scenario and for the residential scenario are below the benchmark of 1 for non-cancer hazard, indicating adverse non-cancer effects are unlikely to occur.~~No risks to human health at SWMU 148 were identified in the risk assessment. The SLERA and BERA completed for SWMU 148 did not identify any current risks to ecological receptors. The desert shrew, which had a refined HQ slightly above 1 in a hypothetical future scenario. However, the affected area of silver with refined HQs greater than 1 for the desert shrew has a very limited spatial extent (less than 0.3 acre). It is important to reiterate here that the above assessment is for a hypothetical future scenario and only applies if the site was redeveloped and the asphalt covering removed. Therefore, there are no ecologically significant current risks at SWMU 148 because of the following reasons. ~~because of the following reasons:The site is currently covered by asphalt which eliminates the exposure pathway for wildlife via a physical barrier.~~

~~The affected area is very limited in spatial extent (less than 0.3 acre). Therefore, exposure by terrestrial wildlife is not expected to cause adverse impacts to exposed receptors. A SLERA and BERA were completed for SWMU 148, to evaluate surface soil and subsurface soil for ecological receptors, and food chain modeling was evaluated for the constituent identified as bioaccumulative. The results of the SLERA~~

~~and BERA for direct contact and the constituents evaluated in the terrestrial food chain models indicate there is adequate information to conclude that there are no significant current exposures to soil and future impacts are unlikely to occur for ecological receptors potentially exposed to constituents in soil.~~

- Based on the overall analysis of the ERA for SWMU 148, the results indicate that if exposure were to occur, then adverse effects are not expected for wildlife that may access the site. Therefore, no further ecological evaluation at SWMU 148 is warranted.

No restrictions need to be applied to current or potential future land use for SWMU 148. Based on soils data and the results of the HHRA and ERA, constituent concentrations in soil do not represent an ongoing source of contamination. Therefore, SWMU 148 is recommended for NFA and should be closed out of the RCRA process.

6.19 SWMUs 149, 151, and 152 – Septic Systems (WSMR-46)

6.19.1 Unit Description

There are three septic systems in use at the main HELSTF complex. They include the following:

- SWMU 149 – HELSTF Maintenance Building (26121) Septic System: located 540 feet southeast of the LSTC. This system consists of a 200-gallon subsurface septic tank and two 4-inch drainage lines that are 30 feet in length. The associated fenced drain field is approximately 70 feet by 30 feet. Only wastewater from Building 26121 is treated in the septic system;

- SWMU 151 – Trailer Area Septic System: located approximately 900 feet southeast of the LSTC and 50 feet west of SWMU 152. The septic system is active; however, office trailers that formerly discharged to this SWMU have been removed. Only the supply building currently uses the septic field. The approximate dimensions of the septic system and drain field are 40 feet by 110 feet; and

- SWMU 152 – Property and Supply Building Septic System: located approximately 50 feet south of Building 26145, east of the HELSTF TCA. The unit consists of a septic system and a drainfield. The approximate dimensions of the septic system

are 110 feet by 40 feet. This unit receives wastewater from Building 26145 and the Trailer Area.

The three systems are situated in relatively close proximity to each other. The septic systems at the Trailer Area and Property and Supply Building are plumbed together.

6.19.2 Operational History

SWMU 149 is currently active and has been operated since the 1960s. SWMUs 151 and 152 are currently active and have been operated since the 1980s. The potential contaminants associated with SWMUs 149, 151, and 152 include those constituents associated with sewage. According to WSMR personnel, these systems once served approximately 100 people, but now only serve approximately 30 people. Although the Phase I RFI report stated that SWMU 149 may have received industrial wastewater from the maintenance building, WSMR personnel indicated that floor drains are not permitted to discharge to septic systems (Reynolds, pers. comm., 2009a).

6.19.3 Regulatory History

The units were not addressed during the RFA conducted during 1988. ~~Due to this condition~~ Therefore, the sites were not included in the 1989 RCRA Permit. The USAEHA identified the sites during an evaluation of environmental conditions at the HELSTF in July 1990. As a result of this evaluation, the USAEHA recommended that additional assessment of these sites be conducted as part of the Phase I RFI. Additionally, on August 7, 1991, the units were added to the RCRA Permit for Appendix IV list sites that required additional investigation.

As described under Section 6.19.4 (Investigative History, page 299), Phase I RFI activities were conducted at all three SWMU locations. This included collection of soil and groundwater data. Data collected during the RFI at the three SWMUs did not indicate significant impacts to soil or groundwater.

Based upon the data collected during the Phase I RFI at SWMU 149, it was concluded that a release from this unit had not occurred. The Phase I RFI Report stated that although there was no evidence of a release, the unit was still active and received wastewater from the maintenance building which may be associated with industrial chemicals, and therefore, periodic monitoring of the two wells located in the area of the SWMU should be continued as long as the leach field is still active. The Phase I RFI Report recommended that the RFI for this SWMU be discontinued (ITC, 1992b).

Based upon the data collected during the Phase I RFI at SWMUs 151 and 152, it was also concluded that a release from these units had not occurred. Based upon these findings, it was recommended that the RFI be discontinued for these SWMUs (ITC, 1992b).

NMED agreed with the NFA recommendations on January 22, 1993. However, WSMR would be required to conduct an ongoing groundwater monitoring program in the HELSTF area (~~ITC, 1992b~~Morgan, 1993). The USEPA approved the Phase I report in a letter dated October 15, 1993 (Honker, 1993).

On October 12, 1993, WSMR formally requested a Class III permit modification to show that SWMU 149 would require no further action under the RFI process. On January 12, 1995, the USEPA issued a *State of Basis/Final Decision and Response to Comments Summary* approving the NFA requests for all three SWMUs (including SWMUs 151 and 152). In response to this action, WSMR formally added SWMUs 151 and 152 to the Class 3 permit modification on February 7, 1995.

However, on August 6, 1999, NMED denied the NFA request for these SWMUs due to the high concentrations of selenium that exist in the HELSTF area (Bearzi, 1999). The units were assessed a fee following the 1998 Annual Unit Audit because they were considered units requiring corrective action.

In a correspondence dated March 23, 2000, WSMR represented their case for NFA status of these three SWMUs. NMED agreed with the March 23, 2000, request and reversed their position. NMED moved SWMUs 149, 151, and 152 to Table A.2 (No Action Required) of the RCRA Permit (Dinwiddie, 2000). The units have remained listed in Table A.2 of the Annual Unit Audits, indicating that NFA is required. However, when the RCRA permit was renewed in December 2009, these SWMUs were listed as SWMUs requiring corrective action (NMED, 2009).

6.19.4 Investigative History

~~A s~~Soil sampling locations ~~summary of monitoring points~~ used to investigate SWMUs 149, 151, and 152 are shown on Figure 6.19-1, and the analytical data for soil are provided in table 6-19~~8. is provided in Table 17 of Appendix D-2.~~ Descriptions of assessments are provided below.

Phase I RFI

At SWMU 149, the Phase I RFI included collection of a background soil sample (149BG), collection of six soil samples from a boring advanced from 5 to 30 ft bgs (HMW-17), installation of two vadose zone monitoring wells (HMW-14 and HMW-17), and collection of groundwater samples from the newly installed monitoring wells. Soil samples were analyzed for VOCs, SVOCs, metals, PCBs/pesticides, and TPH. Groundwater was analyzed for VOCs, SVOCs, metals, and TPH.

Soil data collected at SWMU 149 did not indicate any detection of metals above 1992 action levels. Arsenic was detected in the background sample. Arsenic, lead, and barium were detected at concentrations generally representative of background. One elevated barium concentration (400 mg/kg) was detected in soil from 20 ft bgs in the boring drilled for the installation of HMW-17. This was assumed to be naturally occurring, related to adsorption of the metal to a clay layer underlying the vadose zone water. With the exception of one detection of acetone at 5 ft bgs, no VOCs, SVOCs, TPH, or PCB/pesticide concentrations were detected in soil samples. A notation on the table in the Phase I RFI report indicated that the acetone was introduced to the sample during collection. Groundwater data at SWMU 149 did not indicate any detection of VOCs, SVOCs, or TPH concentrations. Selenium was detected in groundwater from both wells and was noted to be natural in origin, typical of groundwater at the HELSTF, wherein selenium was likely mobilized from the soil due to the high TDS levels in groundwater. Based upon these findings, NFA for SWMU 149 was recommended, with periodic monitoring of the two newly installed vadose zone wells during the active life of the leach field.

At SWMU 151, the Phase I RFI included collection of a background soil sample (151BG), collection of six soil samples from a boring advanced to 30 ft bgs (151B1), and collection of groundwater samples from HMW-12 (installed in conjunction with the Phase I RFI at the adjacent SWMU 152). Soil samples were analyzed for VOCs, SVOCs, and metals. Groundwater was analyzed for VOCs, SVOCs, metals, and TPH.

Soil data collected at SWMU 151 did not indicate any detection of metals above action levels. Arsenic was detected in the background soil sample. Arsenic, barium, and lead were detected at concentrations generally representative of background. One arsenic detection, in soil at 30 ft bgs in 151B1, exceeded background. With the exception of acetone detected at 10 feet, no VOCs or SVOCs were detected in soil samples. A notation on the table in the Phase I RFI report indicated that the acetone was introduced to the sample during collection. Groundwater data for HMW-12 ~~at SWMU~~

~~151~~ did not indicate any detection of VOCs, SVOCs, or TPH concentrations. Selenium was detected at concentrations exceeding its MCL and the groundwater protection standard. However, the RFI report indicated that the detection was reported within the range characteristic of HELSTF groundwater. Based upon these findings, NFA for SWMU 151 was recommended. The Phase I RFI report concluded that, because the trailers had been removed and only the supply building discharges to this unit, there was no need to continue monitoring groundwater from HMW-12 for this unit.

At SWMU 152, the Phase I RFI included collection of a background soil sample (152BG), collection of six soil samples from a boring advanced to 35 ft bgs (152B1), and collection of groundwater samples from HMW-12. Soil samples were analyzed for VOCs, SVOCs, metals, PCBs/pesticides, and TPH, and groundwater was analyzed for VOCs, SVOCs, metals, and TPH, as described above. Barium, cadmium, lead, and arsenic were generally detected at background levels. However, soil collected at 25 ft bgs had slightly elevated concentrations of lead, barium, and arsenic and an elevated lead concentration was detected at 30 ft bgs. The detections were attributed to natural occurrences adsorbed on clay layers between transmissive zones. With the exception of acetone detected at 10 feet, no other target constituents were detected in soil samples. A notation on the table in the Phase I RFI report indicated that the acetone was introduced to the sample during collection. As previously described for SWMU 151, selenium was detected in groundwater from HMW-12 at concentrations exceeding the MCL and the groundwater protection standard. However, the detection was reported within the range characteristic of HELSTF groundwater.

Based upon the results of the assessment, it was determined that there have been no significant releases associated with the three units. Therefore, no additional investigation of these units was required as part of Phase II or Phase III RFI activities. However, groundwater data were collected during the Phase III RFI as part of activities proposed for SWMUs 143 (Chromium~~ate~~ Spill Site) and 148 (Former MAR Waste Stabilization Pond).

Phase II RFI

No Phase II RFI activities were conducted for SWMUs 149, 151, and 152.

Phase III RFI

There has been no history of releases from these SWMUs, and the SWMUs ~~have been~~ were ~~placed~~ on the list of sites eligible for NFA at the time that the Phase III RFI was

conducted. Based upon these conditions, no Phase III RFI activities were proposed for this location. Concentrations of inorganics detected in soil and groundwater during previous investigations were evaluated as part of the overall Phase III RFI activities. Data was collected from Vadose Zone Wells HMW-12 and HMW-14 as part of Phase III RFI activities conducted for SWMUs 27 to 30 and from Vadose Zone Well HMW-17 for SWMU 143.

6.19.5 Nature and Extent of Contamination

The soil boring locations are shown on Figure 6.19-1, and a comprehensive data summary for soil is provided in Table 6-19817 in Appendix D-2.

6.19.5.1 *Shallow Soil (0 to 10 ft bgs)VOCs*

6.19.5.1.1 Shallow Soil (0 to 10 ft bgs)

No VOCs were detected above the NMED SSLs for residential soil or above the DAF 20 screening criteria in shallow soil at SWMUs 149, 151, and 152.

6.19.5.1.2 Deep Soil (Greater than 10 ft bgs)

No VOCs were detected in the deep soils (>10 ft bgs) at these units.

Of the nine samples collected from shallow soil (• 10 ft bgs), two analytes were detected: acetone and arsenic. Table 6.19-1 provides a statistical summary of data for shallow soil and Table 6.19-2 provides a summary of exceedances of regulatory standards for shallow soil at SWMUs 149,151, and 152.

6.19.5.1.1 VOCs

Acetone was the only VOC detected in shallow soils, and no detections exceeded the NMED SSL (28,100 mg/kg). Acetone was detected in three of the nine shallow soil samples designated for this analysis. The maximum acetone detection was 3.90 mg/kg, observed at 152B1 at a depth of 10 ft bgs. As stated previously, the Phase I Report indicated that acetone was introduced to these samples during collection and, therefore, it is not representative of a contaminant associated with these SWMUs. Acetone is a common laboratory artifact and the detection is likely attributable to laboratory contamination. Additionally, it should be noted that this acetone detection is isolated to two samples collected at these SWMUs. Therefore,

~~the acetone detection is not attributed to soil conditions at SWMUs 149, 151, and 152, and acetone is not considered a COPC associated with these SWMUs.~~

6.19.5.2 *SVOCs*

6.19.5.2.1 Shallow Soil (0 to 10 ft bgs)

No SVOCs were detected in the shallow soils (• 10 ft bgs) at ~~this unit~~SWMUs 149, 151, and 152.

6.19.5.2.2 Deep Soil (Greater than 10 ft bgs)

No SVOCs were detected in the shallow soils (• 10 ft bgs) at SWMUs 149, 151, and 152.

6.19.5.3 *Metals*

6.19.5.3.1 Shallow Soil (0 to 10 ft bgs)

No metals were detected above the NMED SSLs for residential soil in shallow soils at these SWMUs. Arsenic, which is attributable to redox-related conditions at the HELSTF was the only metal detected above the DAF 20 criterion at SWMUs 149, 151, and 152. ~~in four of the nine shallow soil samples designated for this analysis. As described under Section 4.3.6 (page 38), arsenic detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMUs 149, 151, and 15~~

6.19.5.3.2 Deep Soil (Greater than 10 ft bgs)

~~6.19.5.3.1~~ With the exception of arsenic, which is attributable to redox-related conditions at the HELSTF, no metals were detected above the DAF 20 in deep soils at these SWMUs.~~Shallow Soil Summary~~

~~In summary, no COPCs were detected above regulatory standards in shallow soils at SWMUs 149, 151, and 152.~~

~~6.19.5.4 *Deep Soil (Greater than 10 ft bgs)*~~

~~At the six soil boring locations where samples deeper than 10 ft bgs were collected, four metals (arsenic, barium, cadmium, and lead) were detected above laboratory~~

~~reporting limits. Table 6.19-3 provides a statistical summary of data for deep soil and Table 6.19-4 provides a summary of exceedances of regulatory standards for deep soil at SWMUs 149, 151, and 152.~~

~~6.19.5.4.1 VOCs~~

~~No VOCs were detected in the deep soils (>10 ft bgs) in this unit.~~

~~6.19.5.4.2 SVOCs~~

~~No SVOCs were detected in the deep soils (>10 ft bgs) in this unit~~.

~~6.19.5.4.3 Metals~~

~~Arsenic, barium, cadmium, and lead were detected in deep soils (>10 ft bgs) at SWMUs 149, 151, and 152. Arsenic was detected in all 12 of the deep soil samples and barium was detected in 11 of the 12 soil samples designated for these analyses. As described under Section 4.3.6 (page 38), arsenic and barium detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMUs 149, 151, and 152.~~

~~Cadmium was detected in only 1 of the 12 deep soil samples designated for this analysis (>10 ft bgs) at 152B1 (30 ft bgs). The detection did not exceed the NMED DAF 1 screening value (1.57 mg/kg). Lead was detected in 8 of the 12 deep soil samples designated for this analysis. The maximum detection of lead detected was 9.9 mg/kg, at HMW-17 (30 ft bgs). There is no NMED DAF 1 screening value for lead.~~

~~6.19.5.5~~6.19.5.4 ~~*Deep Soil*~~ *Summary*

In summary, no COPCs were detected above regulatory standards in shallow or deep soils at SWMUs 149, 151, and 152.

Vadose Zone Wells HMW-14 and HMW-17 are located in the vicinity of SWMU 149 and HMW-12 is located near SWMUs 151 and 152. The depth to water in HMW-14 ranges from approximately 30 to 32.5 ft bgs, the depth to water in HMW-17 ranges from approximately 18 to 22 ft bgs, and the depth to water in HMW-12 ranges from approximately 32.5 to 33 ft bgs. Although chromium was detected above the NMED groundwater standard in vadose zone water from HMW-12 in 2006, the chromium concentration in 2009 was below the NMED groundwater standard. Chromium is not a

COPC associated with sanitary wastewater. The Chromium Spill Site (SWMU 143) is located upgradient of HMW-12 and chromium occurrences in vadose zone water at HMW-12 are attributable to that release.

Selenium, chlorides, fluoride, nitrate, ~~and~~ sulfate, and TDS ~~-~~have been detected above the NMED ~~regulatory~~ groundwater standards in vadose zone water in the vicinity of these SWMUs. ~~from HMW-14 and fluorides and sulfate have been detected above regulatory groundwater standards in vadose zone water from HMW-17.~~ As discussed in Section 4.3.6 (page 44), these constituents are naturally occurring at the HELSTF and are not attributable to releases at SWMUs 149, 151, and 152.~~In addition to chlorides, fluorides, and sulfates, chromium was detected above its regulatory standard in 2006 in vadose zone water from HMW-12. It should be noted that the chromium concentration in this well in 2009 was below the regulatory standarChromium is not a COPC associated with sanitary wastewater. The Chromate Spill at SWMU 143 is located upgradient of HMW-12 and chromium occurrences in vadose zone water at HMW-12 are attributable to that release.~~

A complete discussion of groundwater conditions is provided in Section 6.25 (page 351) and a summary of the groundwater analytical data is provided in Tables 6-~~22~~1 and 6-2~~3~~ ~~of Appendix D-3~~.

6.19.6 Human Health Risk Assessment Findings

The location of SWMU 149 is approximately 500 feet northwest of SWMUs 151 and 152. Thus, data from SWMU 149 were screened separately from those for SWMUs 151 and 152 for risk assessment purposes. A description of risk assessment methodologies and results is provided on page 239~~228~~ of Appendix E.

6.19.6.1 *SWMU 149*

~~6.19.6.1.1 Soil Exposure Scenarios for SWMU 149~~

The results of this data screening process indicate that after comparison to health-based soil screening levels for construction worker exposure, no COPCs were selected for combined surface and subsurface soil at SWMU 149. This demonstrates that the constituent concentrations in combined surface and subsurface soil at SWMU 149 are unlikely to result in adverse health impacts to the identified potential future receptors. No surface soil data were required to be collected for the Phase I, II or III RFI

investigations. Therefore, any exposure to surface soil at SWMU 149 by site workers or future residents is not expected to represent an exposure concern.

Additionally, no COPCs were selected for saturated vadose zone soil water and total soil at SWMU 149, indicating that vapor intrusion is unlikely to result in adverse health impacts. Based on these results, additional human health risk assessment is not warranted for SWMU 149.

~~In accordance with NMED guidance (NMED, 2006a), constituent concentrations in surface soil, and combined surface and subsurface soil were compared to health-based screening levels and the calculated ratios summed. The total ratios were less than the NMED target ratio of 1. The results of this data screening process indicate that after comparison to health-based SSLs for construction worker exposure, no COPCs were selected for combined surface and subsurface soil at SWMU 149. This demonstrates that the constituent concentrations in combined surface and subsurface soil (0 to 10 ft bgs) at SWMU 149 are unlikely to result in adverse health impacts to future construction workers via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, dermal).~~

~~No surface soil (0 to 2 ft bgs) data were required to be collected for the Phase I, II, or III RFI investigations. Therefore, any exposure to surface soil at SWMU 149 by site workers or future residents is not expected to represent an exposure concern.~~

~~6.19.6.1.2 Vapor Intrusion Scenarios for SWMU 149~~

~~The results of this data screening process indicate that after comparison to health-based screening levels for protection of indoor air, no COPCs were selected for saturated vadose zone water and total soil at SWMU 149. This demonstrates that the constituent concentrations in saturated vadose zone water and total soil at SWMU 149 are unlikely to result in adverse health impacts to the following potential receptors via inhalation of indoor air:~~

- ~~Future site workers; and~~
- ~~Future residents (adults and children).~~

6.19.6.2 *SWMUs 151 and 152*

~~6.19.6.2.1 Soil Exposure Scenarios for SWMUs 151 and 152~~

The HHRA for SWMUs 151 and 152 indicates that current and future industrial use of the site would result in potential exposures that are below the regulatory benchmarks for cancer risks and non-cancer hazards. The evaluation also indicates that potential future residential redevelopment of the site would result in potential exposures that are below the regulatory benchmarks for cancer risks and non-cancer hazards. Based on these results, additional risk assessment is not warranted for SWMUs 151 and 152.

~~Data collected during site characterization activities during the RFIs were used in the evaluation of risk to human health. A description of risk assessment methodologies and results is provided on page 253 of Appendix E.~~

~~In accordance with NMED guidance (NMED, 2006a), constituent concentrations in surface soil and in combined surface and subsurface soil were compared to health-based screening levels and the calculated ratios summed. As summarized in Table E.18-HHRA-10 of Appendix E, the total ratios were less than the NMED target ratio of 1. The results of this data screening process indicate that after comparison to health-based soil screening levels for construction worker exposure, no COPCs were selected for combined surface and subsurface soil at SWMUs 151 and 152. This demonstrates that the constituent concentrations in combined surface and subsurface soil (0 to 10 ft bgs) at SWMUs 151 and 152 are unlikely to result in adverse health impacts to future construction workers via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, dermal).~~

~~No surface soil (0 to 2 ft bgs) data were required to be collected for the Phase I, II, or III RFI investigations. Therefore, any exposure to surface soil at SWMUs 151 and 152 by site workers or future residents is not expected to represent an exposure concern.~~

~~6.19.6.2.2 Vapor Intrusion Scenarios~~

~~All detected VOCs in total soil (i.e., vadose zone) were selected as COPCs for the future vapor intrusion evaluation because there are no NMED or USEPA soil screening levels that are protective of the vapor intrusion pathway. The total ELCR values for the future vapor intrusion exposure pathway could not be determined because no carcinogens were detected in the total soil. The total HI values for the future vapor intrusion exposure pathway for the future site worker scenario and for the hypothetical~~

~~future residential scenario are below the benchmark of 1 for non-cancer hazard, indicating adverse non-cancer effects are unlikely to occur.~~

~~No COPCs were selected for saturated vadose zone water at SWMUs 151 and 152, because no volatile constituents were detected in saturated vadose zone water.~~

~~This demonstrates that the constituent concentrations in saturated vadose zone water and total soil at SWMUs 151 and 152 are unlikely to result in adverse health impacts to the following potential receptors via inhalation of indoor air:~~

- ~~Future site workers; and~~
- ~~Future residents (adults and children).~~

6.19.7 Ecological Risk Assessment Findings

6.19.7.1 *SWMU 149*

As described within the ERA presented on page 241~~229~~ of Appendix E, a screening-level risk assessment was completed for SWMU 149. Based on the analysis of available information, there is adequate information to conclude that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in the soil. Therefore, no further ecological evaluation at SWMU 149 is warranted.

6.19.7.2 *SWMUs 151 and 152*

As described within the ERA presented on page 265~~254~~ of Appendix E, a screening-level and baseline risk assessments were completed for SWMUs 151 and 152. After the SLERA, one constituent (i.e., acetone) was selected as a COPEC in combined surface and subsurface soil because the HQ was greater than 1. However, the HQ was only slightly above 1 (i.e., 2) and the sample reporting acetone was collected from a depth of 10 ft bgs, limiting potential exposure to only burrowing animals. Based on these considerations, adverse impacts are not expected for terrestrial wildlife potentially exposed to acetone in surface and subsurface soil at SWMUs 151 and 152. In addition, it should be noted that the acetone detections at these SWMUs were attributed to contamination introduced during sampling and were not attributable to soil conditions at the SWMUs.

6.19.8 Conclusions and Recommendations

6.19.8.1 *SWMU 149*

Only sanitary wastewater is discharged to this SWMU. There have been no COPCs detected above regulatory standards in shallow or deep soils at SWMU 149. Therefore, there is no evidence of a release from SWMU 149. The findings of the human health risk assessment indicated that there are no current or future risks to human health associated with environmental conditions at SWMU 149. In addition, the results of the SLERA indicate there is adequate information to conclude that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in the soil. Therefore, no further ecological evaluation at SWMU 149 is warranted.

There are no environmental impacts associated with SWMU 149 as a result of historical site activities and no restrictions need to be applied to current or potential future land use at the site. Accordingly, the site is recommended for NFA and should be closed out of the RCRA process.

6.19.8.2 *SWMUs 151 and 152*

SWMUs 151 and 152 receive sanitary sewage only. There have been no detections of COPCs above regulatory standards in shallow or deep soils at these SWMUs. Therefore, there is no evidence of a release from SWMUs 151 and 152. The findings of the human health risk assessment indicated that there are no current or future risks to human health associated with environmental conditions at SWMUs 151 and 152. In addition, the results of the SLERA and indicate that there is adequate information to conclude that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in soil. Therefore, no further ecological evaluation at SWMUs 151 and 152 is warranted.

~~An HHRA was conducted for SWMUs 151 and 152 to evaluate exposure to COPCs in surface soil, combined surface and subsurface soil, total soil, and saturated vadose zone water for site workers under current and future land-use conditions, and construction workers and residents (adult and child) under hypothetical future land-use conditions. The HHRA for SWMUs 151 and 152 indicates that current and future industrial use of the site would result in potential exposures that are within or below the regulatory benchmarks for cancer risks and non-cancer hazards. The evaluation also indicates that potential future residential redevelopment of the site would result in~~

~~potential exposures that are within or below the regulatory benchmarks for cancer risks and non-cancer hazards. Based on these results, additional risk assessment is not warranted for SWMUs 151 and 152.~~

~~A SLERA and BERA were completed for SWMUs 151 and 152, to evaluate surface soil and subsurface soil for ecological receptors. The results of the SLERA and BERA for direct contact indicate there is adequate information to conclude that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in soil. Therefore, no further ecological evaluation at SWMUs 151 and 152 is warranted.~~

There are no environmental impacts associated with SWMUs 151 and 152 as a result of historical site activities and no restrictions need to be applied to current or potential future land use at the site. Accordingly, these sites are recommended for NFA and should be closed out of the RCRA process.

6.20 SWMU 150 – MAR Dump Site

6.20.1 Unit Description

There is very little information pertaining to the MAR Dump Site. The unit is located approximately 0.5 mile northeast of the HELSTF TCA and consisted of an open landfill trench approximately 225 feet by 35 feet by 8 feet deep. The site was located in an open field located approximately 1,450 feet east of a dirt road feeding the north entrance gate of the HELSTF testing area and approximately 2,030 feet northeast of the HELSTF testing area north gate (Dow, 1997). Associated with the trench is an approximately 50-foot-diameter spoil pile of excavated soil that is located 40 feet northwest of the trench.

6.20.2 Operational History

The unit is inactive and reportedly was used as a landfill in the 1960s during the operation of the MAR Facility (ITC, 1992). The trench was partially filled with building materials and discarded paint. The waste constituents expected for SWMU 150 are primarily those associated with discarded paint.

6.20.3 Regulatory History

The Mar Dump Site was not addressed during the RFA conducted during 1988 and, therefore was not included in the 1989 RCRA Permit. The USAEHA identified the site

during an evaluation of environmental conditions at the HELSTF in July 1990. As a result of this evaluation, the USAEHA recommended that additional assessment of this site be conducted as part of the Phase I RFI. Additionally, on August 7, 1991, the unit was added to the RCRA Permit for Appendix IV list sites that required additional investigation.

The Phase I RFI was conducted at this SWMU and included recording of field observations of the trench contents, collection of six shallow soil samples from within the trench and collection of one isolated background soil sample. As further described under Section 6.20.4 (Investigative History, page 312), lead, silver, mercury, and barium were detected in shallow soil within the trench, but none of the detected concentrations exceeded the 1992 regulatory action levels. No VOCs or SVOCs were detected in any soil samples (ITC, 1992b).

The RFI Report recommended NFA for SWMU 150. WSMR proposed to perform removal actions at the SWMU. NMED subsequently approved the request on November 20, 1992 (Morgan, 1992a). NMED specified that they would not concur with the recommendation of NFA in the Phase I RFI until the confirmation sampling was conducted following removal actions (Morgan, 1993a).

The removal actions occurred between February 1 and 8, 1996. Large pieces of metal debris were removed from the trench and placed in the WSMR scrap metal facility. Smaller size debris along with the upper 6 inches of soil were excavated and placed in roll-off containers. As described under Section 6.20.4 (Investigative History, page 312), confirmation sampling was conducted following the excavation program. Only low concentrations of leachable silver were detected in three of the eight confirmation soil samples collected from the excavation floor. Low concentrations of leachable barium and chromium were detected in the composite samples from the roll-offs containing debris and soil removed from the trench. All of these detections were well below regulatory limits for hazardous waste and land disposal (Dow, 1997).

Based upon these findings, NMED concurred with WSMR's conclusion and recommendation to remove SWMU 150 from their permit on September 4, 1996 (Kelly, 1996). WSMR provided NMED with a closure report, entitled *Close Out Report – SWMU 150 – MAR Dump Site* that was prepared by Dow, dated January 31, 1997. WSMR submitted an NFA petition for SWMU 150 in January 2000. The petition was denied by NMED on March 11, 2002, because the unit required a final RFI report and ERA (Frischkorn, 2002). The annual unit audits continue to list SWMU 150 as a SWMU requiring corrective action.

6.20.4 Investigative History

~~A summary of monitoring points used to investigate SWMU 150 is provided in Table 18 of Appendix D-26.XXX.~~ Descriptions of assessments are provided below.

Phase I RFI

The field investigation included conducting a visual survey of site-related conditions. Six shallow soil samples were collected from within the trench. One isolated background sample was also collected. Samples were analyzed for VOCs, SVOCs, and metals.

Soil data indicated detections of metals that included arsenic, lead, silver, mercury, and barium ~~that were~~ below 1992 proposed regulatory action levels. Concentrations declined for samples collected below 1 ft bgs. No VOCs or SVOCs were detected in soil samples (ITC, 1992b).

The only significant observation at the SWMU included potential asbestos-containing tiles and insulation. No other signs of contamination were observed (ITC, 1992b).

Based upon these results, it was concluded that there was no evidence of significant releases from SWMU 150. Based upon these conditions, NFA for the unit was recommended. However, WSMR then proposed to perform removal actions at the SWMU. NMED subsequently approved the request on November 20, 1992 (Morgan, 1992a). NMED specified that they would not concur with the recommendation of NFA in the Phase I RFI until the confirmation sampling was conducted following removal actions (Morgan, 1993a).

Confirmation Sampling – Excavation Program

Between February 1 and 8, 1996, Dow conducted removal actions at SWMU 150 that included removal of large pieces of metal debris and excavation and removal of small pieces of debris and 6 inches of underlying soil, confirmation soil sampling, and waste characterization sampling. Eight confirmation soil samples were collected from the trench floor for analyses of TPH-DRO, TPH-GRO, VOCs, PCBs, and eight RCRA metals by TCLP.

No organics were reported above reporting limits. TPH and PCBs were below their respective reporting limits. Results for TCLP metals indicated detections of silver at

two locations at concentrations below TC limits. These results were provided to NMED in the 1997 Dow summary report (Dow, 1997). The trench was backfilled with clean soil, and the area was graded and seeded with grass seed. WSMR submitted an NFA petition for SWMU 150 in January 2000. The petition was denied by NMED on March 11, 2002, because the unit requires a final RFI report and ERA (Frischkorn, 2002).

Phase II RFI

No Phase II RFI activities were conducted at this SWMU.

Phase III RFI

In order to evaluate deeper soils beneath the dump site, three borings (HLSF-SB-007, HLSF-SB-008, and HLSF-SB-009) were advanced to a depth of 50 ft bgs during the Phase III RFI field work. The samples were analyzed for RCRA 8 metals, hexavalent chromium, VOCs, FOC, and nitrite/nitrate. The concentrations of inorganics were compared with background levels established as part of this current evaluation. No VOCs were detected in soil from these borings.

6.20.5 Nature and Extent of Contamination

In order to delineate the extent of soil impacts at SWMU 150, 26 soil samples from six shallow soil borings advanced as part of the Phase I RFI activities and three 50-foot soil borings advanced during the Phase III RFI were evaluated **(**Figure 6.20-1). A comprehensive data summary for soil is provided in Table ~~18 of Appendix D-2~~6~~.-XX~~6-20.

6.20.5.1 *VOCs*

~~6.20.5.1.1~~

~~6.20.5.1.2 VOCs~~Shallow Soil (0 to 10 ft bgs)

~~6.20.5.1.3 Table 6.20-1 provides a statistical summary of data for shallow soil and Table 6.20-2 provides a summary of exceedances of regulatory standards for shallow soil at SWMU 150.~~

6.20.5.1.1 Shallow Soil (0 to 10 ft bgs)

~~6.20.5.1.4 VOCs~~

No VOCs were detected in shallow soils (• 10 ft bgs) at this unit.

6.20.5.1.2 Deep Soil (Greater than 10 ft bgs)

No VOCs were detected in deep soils (>10 ft bgs) at this unit.

6.20.5.2 *SVOCs*

6.20.5.2.1 Shallow Soil (0 to 10 ft bgs)

No SVOCs were detected in shallow soils (• 10 ft bgs) at this unit.

6.20.5.2.2 Deep Soil (Greater than 10 ft bgs)

No SVOCs were detected in deep soils (>10 ft bgs) at this unit.

6.20.5.3 *Metals*

6.20.5.3.1 Shallow Soil (0 to 10 ft bgs)

As shown on Table 6-20~~XXX~~, ~~No~~ no detected metals in shallow soils exceeded NMED SSLs for residential soils (• 10 ft bgs). ~~Metal detections included the following: arsenic, barium, chromium, lead, mercury, and silver.~~

Arsenic ~~and barium were~~was the only metal that was detected in shallow soil at SWMU 150~~; the arsenic detections~~ at concentrations that exceeded the NMED DAF ~~1~~ 20 screening value. ~~These detections do not represent releases of waste constituents from SWMUs or site processes because there were no wastes generated or managed at the HELSTF containing arsenic or barium~~ As described under Section 4.3.6 (page 44), arsenic ~~and barium detections are being~~is being is attribut~~ed~~able to ~~naturally~~redox-related ~~occurring~~ conditions existing at the HELSTF and, therefore, arsenic ~~and barium are~~ is not considered a COPC~~s~~ associated with SWMU 150.

~~No chromium detections exceeded the NMED SSL (2,800 mg/kg) for residential soils. There is no NMED DAF 1 screening level for chromium. Chromium detections were observed at HLSF-SB-007, HLSF-SB-008, and HLSF-SB-009. The maximum detection was 9.06 mg/kg, at HLSF-SB-008 (0.5 to 1 ft bgs).~~

~~No lead detections exceeded the NMED SSL (400 mg/kg) for residential soils. There is no NMED DAF 1 screening level for lead. Lead detections were observed at 150S1, HLSF-SB-007, HLSF-SB-008, and HLSF-SB-009. The maximum detection was 58 mg/kg, at 150S1 (1 ft bgs).~~

~~No mercury detections exceeded the NMED SSL for residential soil (100,000 mg/kg). Mercury detections exceeding the NMED DAF 1 (0.105 mg/kg) were observed at 150S1 (1 ft bgs), 150S2 (1 ft bgs), 150S3 (1 ft bgs), and 150S5 (3 ft bgs). The maximum detection of mercury was 0.300 mg/kg, observed at 150S1 at a depth of 1 ft bgs. Detections of mercury appear to be localized in shallow soils at these locations because no detections of mercury were detected in surrounding borings (HLSF-SB-007, HLSF-SB-008, or HLSF-SB-009).~~

~~No silver detections exceeded the NMED SSL for residential soil (391 mg/kg). Silver exceeding the NMED DAF 1 (1.57 mg/kg) was detected at 150S1 (1 ft bgs), 150S2 (1 ft bgs), 150S3 (1 ft bgs), and 150S6 (1 ft bgs). The maximum detection of silver was 7.60 mg/kg, observed at 150S1 and 150S3 at a depth of 1 ft bgs at each location. Detections of silver appear to be localized in shallow soils at these locations because no detections of silver were detected in surrounding borings (HLSF-SB-007, HLSF-SB-008, or HLSF-SB-009).~~

6.20.5.3.2 Deep Soil (Greater than 10 ft bgs)

As shown on Table 6-20~~XXX~~, arsenic is the only metal that was detected at concentrations above DAF 20. As described under Section 4.3.6 (page 44), arsenic detections are attributable to ~~naturally occurring~~ redox-related conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 150.

6.20.5.4 ~~*Shallow*~~ *Soil Summary*

~~Shallow Soil (0 to 10 ft bgs)~~

In summary,~~mercury and silver were the only detected COPCs exceeding a regulatory standard in shallow soils at SWMU 150. Mercury detections (150S1, 150S2, 150S3, and 150S5) and silver detections (150S1, 150S2, 150S3, and 150S6) in soil exceeded their respective NMED DAF 1 screening values. A map depicting the exceedances of the DAF 1 screening values in shallow soils at SWMU 150 is provided as Figure 6.20-2~~ there were no detected concentrations of COPCs associated with this SWMU that exceeded NMED SSLs for residential soil or DAF 20 screening criteria in shallow soil and no detected concentration of COPCs in soil at depths greater than 10 ft bgs that exceeded the DAF 20 screening criteria.~~Deep Soil Summary~~

~~In summary, there were no detected concentrations of COPCs associated with this SWMU that exceeded NMED SSL or DAF 20 in soil at depths greater than 10 ft bgs~~

~~6.20.5.3 *Deep Soil (Greater than 10 ft bgs)*~~

~~Table 6.20-3 provides a statistical summary of data for deep soil and Table 6.20-4 provides a summary of exceedances of regulatory standards for deep soil at SWMU 150.~~

~~VOCs~~

~~No VOCs were detected in deep soils (>10 ft bgs) at this unit.~~

~~6.20.5.3.1 SVOCs~~

~~No SVOCs were detected in deep soils (>10 ft bgs) at this unit.~~

~~6.20.5.3.2 Metals~~

~~Arsenic, barium, chromium, and lead were all detected in soil samples collected deeper than 10 ft bgs at SWMU 150 (Table 6.20-3). As described under Section 4.3.6 (page 41), arsenic and barium detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 150.~~

~~Chromium detections were observed at HLSF-SB-007, HLSF-SB-008, and HLSF-SB-009. The maximum chromium detection in deep soil was 16.9 mg/kg, at HLSF-SB-007 (40 to 41 ft bgs). There is no NMED DAF 1 screening level for chromium.~~

~~Lead detections were observed at 150S1, HLSF-SB-007, HLSF-SB-008, and HLSF-SB-009. The maximum lead detection in deep soil was 37.1 mg/kg. There is no NMED DAF 1 screening level for lead.~~

~~6.20.5.3.3 Deep Soil Summary~~

~~In summary, lead and chromium were the only constituents detected in deep soils. All of these detections occurred at depths greater than 10 ft bgs and, therefore, do not represent an exposure risk to human health or to ecological receptors. Silver and mercury, detected in shallow soils above regulatory standards, were not detected in deep soils.~~

6.20.6 Human Health Risk Assessment Findings

Data collected during site characterization activities during the RFIs were used in the evaluation of risk to human health. A description of risk assessment methodologies and results is provided on page 249~~237~~ of Appendix E.

The results of this data screening process indicate that after comparison to health-based soil screening levels for industrial worker exposure, residential exposure, and construction worker exposure, no COPCs were selected for surface soil, or for combined surface and subsurface soil at SWMU 150. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMU 150 are unlikely to result in adverse health impacts to the identified current and potential future receptors. Additionally, no VOCs were detected in soil, indicating

that vapor intrusion is unlikely to result in adverse health impacts. Based on these results, additional human health risk assessment is not warranted for SWMU 150.

~~Exposure Scenarios~~

~~In accordance with NMED guidance (NMED, 2006a), constituent concentrations in surface soil and in combined surface and subsurface soil were compared to health-based screening levels and the calculated ratios summed. The total ratios were less than the NMED target ratio of 1. The results of this data screening process indicate that after comparison to health-based SSLs for industrial worker exposure, residential exposure, and construction worker exposure, no COPCs were selected for surface soil or for combined surface and subsurface soil at SWMU 150. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMU 150 are unlikely to result in adverse health impacts to the following potential receptors via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, dermal):~~

~~Current and future site workers;~~

~~Future residents (adults and children); and~~

~~Future construction workers.~~

~~Vapor Intrusion Scenarios~~

~~No VOCs were detected in total soil. Therefore, no COPCs were selected for total soil at SWMU 150. This demonstrates that the constituent concentrations in total soil at SWMU 150 are unlikely to result in adverse health impacts to the following potential receptors via inhalation of indoor air:~~

~~Future site workers; and~~

~~Future residents (adults and children).~~

6.20.7 Ecological Risk Assessment Findings

As described within the ERA presented on page 250~~238~~ of Appendix E, a SLERA and BERA were completed for SWMU 150. After the SLERA, three constituents (i.e., lead, mercury, and silver) were selected as COPEC in surface soil and in combined surface and subsurface soil because the HQs were greater than 1. In the BERA, lead,

mercury, and silver were retained for further evaluation in the food chain modeling because they were identified as bioaccumulative.

Tables E.17.ERA-20 and E.17.ERA-21 of Appendix E summarize the constituents in surface soil and in combined surface and subsurface soil that were carried through the BERA and evaluated in the terrestrial food chain model. As shown in these tables, all receptors evaluated in the terrestrial food chain refined scenarios had LOAEL and NOAEL HQs less than or equal to 1 with the exception of the desert shrew. The desert shrew had refined NOAEL HQs slightly above 1, and refined LOAEL HQs less than 1 for mercury and silver. However, considering that the LOAEL HQs are below 1, and the NOAEL HQs are only marginally above 1 (for mercury and silver), and that the areal extent of affected soil at SWMU 150 is small, adverse impacts are unlikely to occur for desert shrew, and for other insectivorous mammals, if exposed to mercury and silver at SWMU 150. Based on the overall analysis of the ERA for SWMU 150, the results indicate that if soil exposure were to occur, then adverse effects are not expected for wildlife that may access the site.

6.20.8 Conclusions and Recommendations

Soil conditions at SWMU 150 (MAR Dump Site) have been adequately characterized. Debris and underlying soil were removed from the site in 1996 and confirmation soil samples were collected from the bottom of the trench. The trench was backfilled with clean fill. During the RFIs, there were no detected concentrations of COPCs associated with this SWMU that exceeded NMED SSLs for residential soil or DAF 20 screening criteria in shallow soil and no detected concentration of COPCs in soil at depths greater than 10 ft bgs that exceeded the DAF 20 screeening criteria.

~~Soil samples collected before the debris and underlying soil were removed from the trench did not contain concentrations of constituents of potential concern above the SSLs for residential soil. Mercury and silver were the only COPCs detected above regulatory standards (i.e., NMED DAF 1). These exceedances were localized occurrences in shallow soil samples (1 to 3 ft bgs). Although mMercury and silver do not exceeded the NMED DAF 1 20 in shallow soils, no detections were observed in soils greater than 10 ft bgs. In addition, there are no sources currently present to generate or mobilize the detected constituents. SWMU 150 was closed in 1996, trench contents were emptied, and confirmatory soil samples collected. No impacts to soil were detected in the confirmatory samples. The trench was backfilled with clean soil, the site was graded, and grass seed was applied to the area. No other COPCs were detected above regulatory standards for residential soil.~~

There were no risks to current or future receptorts identified by the ~~An~~ HHRA. ~~was conducted to evaluate exposure to COPCs in surface soil, combined surface and subsurface soil, total soil, and saturated vadose zone water for site workers under current and future land-use conditions, and construction workers and residents (adult and child) under hypothetical future land-use conditions. The constituent concentrations in surface soil and in combined surface and subsurface soil at SWMU 150 are unlikely to result in adverse health impacts to the identified current and potential future receptors. Additionally, no VOCs were detected in soil, indicating that vapor intrusion is unlikely to result in adverse health impacts. Based on these results, additional human health risk assessment is not warranted for SWMU 150. A SLERA and BERA were completed for SWMU 150 to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents detected in surface soil and subsurface soil and to conduct food chain modeling for the COPECs identified as bioaccumulative.~~ The results of the SLERA and BERA for direct contact exposure and for food chain modeling indicate there is adequate information to conclude that there are no significant current exposures to soil and future impacts are unlikely to occur for ecological receptors potentially exposed to constituents in soil. Therefore, no further ecological evaluation at SWMU 150 is warranted.

There are no environmental impacts associated with SWMU 150 as a result of historical site activities and no restrictions need to be applied to current or potential future land use at the site. Accordingly, the site is recommended for NFA and should be closed out of the RCRA process.

6.21 SWMU 154 – Systemic Diesel Spill (WSMR-55)

6.21.1 Unit Description

A 30,000-gallon diesel UST was installed at the staging area on the east side of Test Cell No. 2 between 1979 and 1980. A 2-inch fuel oil supply line was installed in 1981 to connect the UST to Test Cell No. 2 (approximately 120 feet to the south) and to the HCF (approximately 360 feet to the east-northeast).

6.21.2 Operational History

The UST was operated from 1980 to 1988 to supply diesel fuel to a gas turbine generator at Test Cell No. 2 and for boilers located at the HCF. The UST was removed in April 1988 as part of a facility-wide underground tank replacement program when aboveground storage of fuel became the preferred material handling practice. A

release of fuel from the supply line for the HCF boilers was discovered in 1990 during an investigation of the HCF Sump (SWMU 142). The release was attributed to corrosion due to alkaline soils. Estimates of product loss ranged from 100,000 to 175,000 gallons (LESC, 1991d).

6.21.3 Regulatory History

The systemic diesel spill was not identified in either of the two RFAs prepared in 1988. ~~Due to these conditions~~Therefore, the unit was not part of the initial RCRA HSWA Permit issued on October 24, 1989. SWMU 154 is listed on the current (2009) RCRA permit as a SWMU requiring corrective action (NMED, 2009).

As previously described, the release was identified during an investigation beneath the HCF. Diesel fuel contamination was identified in soils at 11 ft bgs and free product at 20 ft bgs. In April 1990, Monitoring Well HCF-01 was installed at the south side of the HCF and 12 feet of product was found on the vadose zone water table (LESC, 1990). Following notification of the release, the USEPA approved the addition of SWMU 154 ~~as~~ to Appendix IV ~~sites~~ of the permit on August 7, 1991 (Davis, 1991a). The USEPA also required WSMR to implement IRM for SWMU 154 at thatis time.

A draft IRM work plan was prepared and submitted to the USEPA and NMED. The NMED provided comments regarding the plan on September 20, 1991 (Morg~~o~~an, 1991b). The USEPA issued their comments regarding the work plan on October 8, 1991 (Honker, 1991). WSMR incorporated the comments from the USEPA and NMED and a revised plan entitled “Interim Remediation Measures Work Plan”, dated October 29, 1991, was submitted to both agencies. The IRM work plan included pumping the free product fuel directly from Monitoring Well HCF-01.

NMED and the USEPA approved the revised IRM work plan in 1991. The Phase I RFI (Appendix II, III, and IV sites) was conducted between April and June 1992, simultaneously with the ongoing IRM. Soil and groundwater samples were collected from Vadose Zone Wells HMW-10 and HMW-13 and analyzed for VOCs, SVOCs, metals, and TPH. The RFI report recommended that no activities be conducted under the RFI for SWMU 154 until the completion of the IRM. It also recommended continued sampling of Wells HMW-10 and HMW-13 as part of the Phase II RFI for SWMU 143. NMED concurred with the Phase I RFI recommendations for SWMU 154 on January 22, 1993 (Morga~~o~~n, 1993a). Work activities associated with the IRM were completed in August 1992 with the installation of two additional vadose zone monitoring wells (HCF-02 and HCF-03) as well as collection of soil data from 17

borings. Soil and groundwater samples ~~were collected~~analyzed for ~~analyses of~~ TPH and VOCs. ~~concentrations~~. A summary report for the IRM work was ~~completed during~~submitted to the NMED and the USEPA in July 1994. ~~and issued to NMED and the USEPA.~~ The report concluded that soil and groundwater contamination ~~conditions~~ had been delineated.

Additionally, a pneumatic (product only) skimming pump was installed in Monitoring Wells HCF-01, HCF-02, and HCF-03. It was reported that more than 500 gallons of diesel was initially recovered from the system. The production gradually dropped to less than 55 gallons per month. Additional skimming pumps were added as more wells were installed in the product plume. The skimmers were operated until 1995, when they were replaced by a more aggressive recovery system.

In October 1992, NMED concurred with WSMR's request to coordinate activities related to the RCRA closure of the cleaning facility tank system (SWMUs 31 and 32) with the RFI process at the cleaning facility (SWMU 142) and Systemic Diesel Spill (SWMU 154), and the IRM.

A new work plan for continuing the IRM at SWMU 154 was submitted ~~during~~ in February 1993. In response, NMED requested that additional borings be installed along the ~~path of the~~ diesel supply line and that the proposed groundwater and/or product flow modeling include consideration of the pumping effects on SWMUs 142 and 143. The work plan was revised and resubmitted ~~during~~ in March 1993.

The second phase of the IRM was conducted between April and June 1993. This program included advancing four borings (SB1~~, and~~ SB3, SB4, and SB5) and installing four vadose zone monitoring wells (HCF-05, HCF-07, HCF-08, and HCF-09) and four piezometers (PZ1 through PZ4). In addition to collecting soil and groundwater samples, a skimming efficiency test, an aquifer step drawdown test, a vacuum enhanced pumping test, and vadose zone/in-situ aquifer bioassessment were conducted.

The IRM assessment delineated the LNAPL boundaries and provided enough data to develop a remedial system for LNAPL removal. Two remedial options, total fluids pumping and vacuum enhanced pumping, were proposed based on the results of ~~all~~ related investigation and modeling activities. A Final Interim Remedial Measures Report that included a proposed ~~Diesel~~ diesel ~~Recovery~~ recovery ~~System~~ system was ~~accepted~~ approved by the USEPA on July 26, 1994 (Honker, 1994).

The proposed ~~Diesel~~ diesel ~~Recovery~~ recovery ~~System~~ system was installed between November 1994 and January 1995 and included ~~the installation of~~ six extraction wells (DRW-01 through DRW-06). These wells combined with existing Wells HCF-01, HCF-02, HCF-03, HCF-05, and HCF-07 made up the network of 11 skimming wells. All 11 wells were completed within the vadose zone water (formerly referred to as the lower perched aquifer) and have screen intervals from approximately 35 to 55 ft bgs. A vacuum was applied to five of the pumping wells. The vacuum system was operated by a 20-horsepower, 500-cubic-foot-per-minute (cfm) blower in line with six skid-mounted carbon tanks. The system became fully operational on May 15, 1995. An Interim Remedial Measures Report and Operations and Maintenance Manual were submitted to the USEPA and NMED for the recovery system ~~during~~ in May 1995.

A Remedial Action Plan (RAP) that addressed commingled~~overlapping~~ groundwater contamination in the ~~-~~vadose zone water ~~-~~at SWMUs 142, 143, and 154 was initiated in 1996. Eleven new extraction wells were installed in 1997 as part of the RAP. Seven extraction wells (DRW-07 through DRW-13) were installed in the vadose zone water. Four wells (DRW-14 through DRW-17) were installed in the Regional Aquifer.

The Groundwater RAP was finalized in 1997 with a pump and treat system selected as the most feasible approach. Slug tests were performed on 16 wells near the Systemic Diesel Spill site in May 1997. The RAP was never implemented.

Semiannual Groundwater monitoring has been conducted at SWMU 154 since 1998 ~~as part of the RAP~~ as detailed in *Work Plan for the Monitoring Well Program at White Sands Missile Range, New Mexico* (dated January 30, 1995). The wells ~~monitoringed~~ monitored include DRW-01 through DRW-05, DRW-12, DRW-13, DRW-16, HCF-01, HCF-05, and HCF-07.

6.21.4 Investigative History

The soil sampling locations used to investigate SWMU 154 are shown on Figure 6.21-1 and a summary of the soil analytical data is provided in Table 6-201~~-19 of Appendix D-2~~. Descriptions of historical assessment activities ~~s~~ are provided below.

Phase I RFI

The Phase I RFI was conducted between April and June 1992. Soil and groundwater samples were collected from two locations, HMW-10 and HMW-13. Samples were analyzed for VOCs, SVOCs, metals, and TPH.

Soil samples yielded detections of arsenic, barium, cadmium, and lead at concentrations below background values established during the Phase I RFI and/or 1992 regulatory ~~levels~~standards. TPH ~~action levels~~standards were exceeded in the 15- and 20-foot samples from HMW-13; the exceedances corresponded with discoloration and high PID readings. Numerous VOCs and SVOCs related to the diesel spill were detected in the soil samples but no concentrations exceeded 1992 ~~action levels~~standards.

Groundwater samples yielded detections of selenium at levels below background values established during the Phase I RFI. No product was observed floating in either well; however, product and ~~heavily-~~contaminated water were identified in nearby IRM wells (see IRM Assessment – Second Phase).

~~Pending completion of the IRM, no activities conducted under the RFI were recommended for SWMU 154. It was recommended that, during the Phase II RFI, HMW-10 and HMW-13 be analyzed for TDS, hexavalent, and total chromium.~~*IRM Assessment – First Phase*

In 1991, the USEPA required WSMR to begin IRM ~~for~~ at SWMU 154. An IRM work plan was submitted in 1991 and USEPA approval was received on December 7, 1991 (Davis, 1991). The IRM assessment was initiated in early 1992 and completed ~~by~~ in August 1992. Two monitoring wells, HCF-02 and HCF-03, were installed as part of this assessment. Soil samples were also collected from 17 soil borings listed in Table 6-210~~ 19 of Appendix D-2~~. All soil samples were analyzed for TPH concentrations. If the TPH exceeded the reporting limit of 40 mg/kg, VOC and metals analyses were also performed. The assessment report for this investigation was finalized in July 1994.

IRM Assessment – Second Phase

A new work plan ~~providing~~ for continuing IRM at SWMU 154 was submitted to NMED in March 1993. The Second Phase of the IRM Assessment was conducted between April and June 1993. It included advancing four soil borings (SB-1 and SB3 through SB5), four monitoring wells (HCF-05, HCF-07, HCF-08, and HCF-09) and four piezometers (PZ1 through PZ4). In addition to collecting soil and groundwater data, other activities included a skimming efficiency test, an aquifer step drawdown test, a vacuum enhanced pumping test and a vadose zone/in-situ aquifer bio-assessment. The results of the investigation were used to delineate a~~n~~ LNAPL plume and to evaluate the design of a remedial system to remove LNAPL. The Final IRM report was

submitted in December 1993 and was approved by the USEPA on July 26, 1994 (Honker, 1994).

Phase II RFI

No activities were conducted at SWMU 154 during the HELSTF-wide Phase II RFI. ~~process.~~

Phase III RFI

As part of the Phase III RFI, five 50-foot soil borings (HLSF-0085-SB-011, HLSF-0085-SB-015, HLSF-0085-SB-019, HLSF-0085-SB-020, and HLSF-0085-SB-021) were installed and one new monitoring well (HMW-65) was installed in the Regional Aquifer. Well HMW-65 was installed as an upgradient well for the SMWU 142/143/154 release area. Soil samples were collected from approximately every 10 feet in each of the borings. Surface samples were not collected due to asphalt and/or cement covering the site. Soil samples were analyzed for nitrate-nitrite, total phosphorus, total chromium, hexavalent chromium, lead, sodium, zinc, ethylene glycol, VOCs, SVOCs, DRO, GRO, and TOC. With one exception, all of the detected organics came from the area of the diesel spill and all are typical constituents of diesel fuel. No chlorinated hydrocarbons/ solvents were detected in the soil samples.

Groundwater samples were collected from the following vadose zone monitoring wells: DRW-05, DRW-06, DRW-07, DRW-08, DRW-11, DRW-12, and DRW-13. Vadose zone Monitoring Well DRW-12 had selenium results near 0.1 mg/L, although historical concentrations of selenium in this well averaged 0.23 mg/L. Chlorinated hydrocarbons were detected in ~~-~~vadose zone water samples from Monitoring Wells DRW-05 through DRW-08, DRW-12, and DRW-13. Vadose zone Monitoring Wells DRW-01, DRW-02, DRW-03, and DRW-04 were all dry during the Phase III RFI sampling event.

Groundwater samples were collected from the following regional monitoring wells: DRW-15, DRW-16, DRW-17, HMW-55, HMW-64, and HMW-65. In general, r~~R~~egional aquifer wells~~, for the most part,~~ reflected the quality of the regional system, which includes elevated alkalinity, chloride, fluoride, nitrate, sulfate, sodium, and TDS concentrations.

Semiannual Sampling

Groundwater sampling has been conducted semiannually at SWMU 154 since 1998 at Monitoring Wells DRW-01 through DRW-05, DRW-12, DRW-13, DRW-16, HCF-01, HCF-05, and HCF-07.

6.21.5 Nature and Extent of Contamination

~~6.21.5.1~~ *The soil boring locations used to evaluate SWMU 154 are shown on Figure 6.21-1, and a comprehensive soil analytical data table is provided in Table 6-21019 of ~~Appendix D-2~~.~~Shallow Soil (0 to 10 ft bgs):~~*

~~Of the 28 sample locations evaluated for shallow soil (• 10 ft bgs), the only analyte detections exceeding regulatory levels (NMED SSL and/or DAF 1) were arsenic, antimony, iron, 1,2,4-TMB, and 1,3,5-TMB. Table 6.21-1 provides a statistical summary of data for shallow soil and Table 6.21-2 provides a summary of exceedances of regulatory standards for shallow soil at SWMU 154.~~

6.21.5.1 *VOCs*

6.21.5.1.1 VOCs in Shallow Soil (0 – 10ft bgs)

No VOCs ~~detections~~ detected in shallow soils exceeded any regulatory standards (NMED SSLs and/or DAF 1) ~~NMED SSLs (• 10 ft bgs)~~ at SWMU 154. ~~this uni~~Isopropylbenzene, n-propylbenzene, and sec-butylbenzene were the only VOC ~~detections in shallow soils at SWMU 154, and none exceeded the respective NMED SSL or DAF 1 residential SSLs (Figure 6.21-2). The analytical data for SWMU 154 are summarized on Table 6.21-1.~~

6.21.5.1.2 VOCs in Deep Soil (Greater than 10 ft bgs):

VOCs that were detected in the deep soils (greater than 10 ft bgs) at concentrations exceeding the DAF1 values included: 1,1,2,2-tetrachloroethane, 1,1-DCA, 1,2-DCA, 2-butanone, acetone, benzene, bromomethane, carbon tetrachloride, chlorodibromomethane, chloroform, chloromethane, dichloromethane, ethylbenzene, isopropylbenzene, m,p-xylene, o-xylene, PCE, TCE, vinyl chloride, and total xylenes. The majority of these constituents (1,1,2,2-tetrachloroethane, 1,1-DCA, 1,2-DCA, 2-butanone, acetone, bromomethane, carbon tetrachloride, chlorodibromomethane, chloroform, chloromethane, dichloromethane, PCE, TCE, and vinyl chloride) are

solvent related VOCs that are not considered COPCs associated with SWMU 154, but are a result of the commingled release from nearby SWMU 142, which is addressed in Section 6.12 (page 191). The COPCs associated with the release at SWMU 154 and detected at concentrations exceeding the DAF 1 values include benzene, ethylbenzene, isopropylbenzene and xylenes. The VOCs that were identified as COPCs for SWMU 154 and had one or more detections that exceeded the DAF 1 screening criteria are shown on Figure 6.21-2.

Detections of benzene exceeding the NMED DAF 1 screening value of 0.001 mg/kg were observed at the following locations: 142B2 (19, 21, 23, and 27 ft bgs), 142B3 (23, 25, 29, 35, and 39 ft bgs), CFW-01 (39 and 41 ft bgs), CFW-02 (23 to 25 ft bgs, 33 to 35 ft bgs, and 53 to 55 ft bgs), CFW-03 (18 to 20 and 38 to 40 ft bgs), DRW-02 (40 ft bgs). ~~HCF-02 (25 to 30, 35 to 40, and 40 to 45 ft bgs),~~ HCF-03 (25 to 30, 35 to 40, and 40 to 45 ft bgs), HCF-NE100 (20 to 25 and 60 ft bgs), HCF-NE200 (20 to 25 ft bgs), HCF-SW100 (70 ft bgs), HCF-W100 (70 ft bgs), HLSF-SB-011 (40 to 42 ft bgs), HMW-13 (20 ft bgs), N100 (20 to 25, 25 to 30, and 70 ft bgs), N200 (60 ft bgs), SB7/CFW-03 (18 to 20 and 38 to 40 ft bgs), SB8/CFW-02 (23 to 25, 33 to 35, and 53 to 55 ft bgs), and SE-100 (14.5 to 16, 19.5 to 21, 24.5 to 26, 29.5 to 31, and 44.5 to 46 ft bgs).

The maximum detection of benzene was 1.4 mg/kg, detected at DRW-02 at 40 ft bgs. All detections of benzene occurred in deep soils (>10 ft bgs) and are primarily concentrated in the area of the HCF with isolated detections to the south, southwest, and southeast of SWMU 154. Benzene exceedances are laterally delineated as shown on the map on Figure G-12 in Appendix G ~~-12~~G ~~(G-11~~). DAF 1 exceedances at 142B2, CFW-01, CFW-02, CFW-03, DRW-02, ~~HCF-02,~~ HCF-03, HLSF-SB-011, HMW-13, SB7, and SB8 are delineated vertically because there are no detected exceedances in deeper soils. DAF 1 exceedances in 142B3, HCF-NE100, HCF-SW100, HCF-W100, N100, N200, and SE100 most likely occur in saturated soils (approximate depth to water 40 to 45 ft bgs) and have, therefore, been delineated vertically in the soil column at these locations. The general delineation of benzene in deep soil at the HELSTF is shown on Figure G-12 in Appendix G ~~-12on Figure G-12 in Appendix G~~. Benzene exceedances in the vadose zone water were observed at Wells DRW-01, DRW-02, DRW-03, DRW-04, DRW-05, HCF-02, HCF-03, HCF-05, and HCF-07; however, no benzene detections were observed in the Regional Aquifer.

Detections of ethylbenzene exceeding the NMED DAF 1 screening value of 0.0146 mg/kg were observed at the following locations: 142B3 (19, 23,25, 29, 35 and 39 ft bgs), CFW-01 (35, 37, 39 and 41 ft bgs), CFW-02 (18 to 20, 23 to 25, 28 to 30, and 33

ft bgs), CFW-03 (23 to 25 ft bgs), DRW-01 (30 ft bgs), DRW-02 (30 and 40 ft bgs), HCF-02 (15 to 20 and, 20 to 25~~, 25 to 30, 30 to 35, 35 to 40, 40 to 45, and 50 to 55~~ ft bgs),~~S~~ HCF-03 (20 to 25, 25 to 30, 30 to 35, 35 to 40, and 40 to 45 ft bgs), HCF-NE100 (20 to 25, 40 to 45, and 60 ft bgs), HCF-S100 (12 to 13, 13.5 to 15 and 23.5 to 25 ft bgs), HCF-W100 (35 to 40 ft bgs), HLSF-SB-011 (40 to 42 ft bgs) and N100 (20 to 25 and 25 to 30 ft bgs).

The maximum detection of ethlylbenzene was 1.4 mg/kg, detected at HCF-03(25 to 30 ft bgs). All detections of ethylbenzene occurred in deep soils (>10 ft bgs) and are primarily concentrated in the area of the HCF with isolated detections to the southwest of SWMU 154. Ethlylbenzene exceedances are laterally delineated as shown on Figure G-13 in Appendix G~~-13on Figure G-13 the map in Appendix G (G-12).~~ . DAF 1 exceedances at 142B3, CFW-01, (35, 37, 39 and CFW-02 , CFW-03, DRW-01, DRW-02, HCF-02, HCF-03, HCF-S100, HCF-W100, HLSF-SB-011, and N100 are delineated vertically because there are no detected exceedances in deeper soils from these borings. The DAF1 exceedances at HCF-NE100 most likely occurs in saturated soils (approximate depth to water at approximately 45 ft bgs) and have, therefore, been delineated vertically in the soil column at these locations. Ethylbenzene concentrations do not exceed regulatory standards in the vadose zone water or Regional Aquifer.

The maximum detection of isopropylbenzene was 5.00 mg/kg observed in DRW-02 at 40 ft bgs. Isopropylbenzene was detected at concentrations exceeding the NMED DAF 1 screening value (0.986 mg/kg) in soil samples from DRW-01 (30 ft bgs), DRW-02 (30 and 40 ft bgs) and HLSF-SB-011 (40 to 42 ft bgs). No exceedances were observed in deeper soil samples from these borings, therefore, the vertical extent of the isopropylbenzene was delineated. The DAF exceedances occur in a relatively small area in the immediate vicinity of SWMU 154, and data from surrounding borings provide lateral delineation as shown on Figure G-14 in Appendix G~~-14on Figure G-X14 in Appendix G.~~ .

Xylenes (m,p-xylenes, o-xylenes and/or total xylenes) were detected at concentrations exceeding their respective DAF 1 screening values in soil samples from 142B2 (19 and 27 ft bgs), 142B3 (24, 25, 29 and 35 ft bgs), CFW-02 (53 to 55 ft bgs), CFW-03 (18 to 20, 23 to 25, and 38 to 40 ft bgs), DRW-01 (30 ft bgs),DRW-02 (30 and 40 ft bgs), HCF-02 (~~15 to 20 and~~ 35 to 40 ft bgs), HCF-03 (15 to 20 ft bgs), HCF-NE100 (20 to 25 ft bgs) and N100 (20 to 25 and 25 to 30 ft bgs). No detection concentrations in deeper soil samples from 142B2, 142B3, CFW-03, DRW-01, DRW-02, HCF-02, HCF-03, HCF-NE100, and N100 exceeded the DAF 1 screening values. Therefore, the vertical extent of the xylenes was delineated. The sample collected from CFW-02 (53

to 55 ft bgs) most likely occur in saturated soils (approximate depth to water 40 to 45 ft bgs) and has, therefore, been delineated vertically in the soil column at this locations. ~~(53 to 55 ft bgs.~~ Xylenes concentrations do not exceed regulatory standards in the vadose zone water or in the Regional Aquifer. The DAF 1 exceedances occur in a relatively small area in the immediate vicinity of SWMU 154, and in isolated locations to the south and southeast of SWMU 154. Data from surrounding borings provide lateral delineation of xylenes as shown on Figure G-15 in Appendix G~~-15on Figure G-153 in Appendix G.~~.

~~6.21.5.1.2~~6.21.5.1.3 SVOCs

6.21.5.1.4 SVOCs in Shallow Soil (0 – 10ft bgs)

No SVOCs were detected in shallow soils at SWMU 154. ~~above NMED SSLs. 1,2,4-TMB and 1,3,5-TMB were the only two detections of SVOCs in the shallow soils (• 10 ft bgs). The detections of 1,2,4-TMB (0.740 mg/kg) and 1,3,5-TMB exceeded the exceeded the NMED DAF 1 screening values of 0.0709 mg/kg and 0.0177 mg/kg, respectively. 1,2,4-TMB and 1,3,5-TMB are considered COPCs and are indicative of releases associated with SWMU 154. SVOC exceedances of regulatory standards are shown in Figure 6.21-3. The general lateral delineation of 1,2,4-TMB in shallow soil at the HELSTF is shown on Figure G-9 and the general lateral delineation of 1,3,5-TMB in shallow soil at the HELSTF is shown on Figure G-10 in Appendix G.~~

6.21.5.1.5 SVOCs in Deep Soil (Greater than 10 ft bgs)

SVOC detections included the following: 1,2,3-trichlorobenzene, 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, anthracene, benzoic acid, BEHP, dibenzofuran, diphenylamine, fluoranthene, fluorene, n-nitrosodiphenylamine, phenanthrene, and pyrene. As indicated in Table 6.1-1, diphenylamine and N-nitrosodiphenylamine are not COPCs associated with wastes generated at the HELSTF. There are no DAF 1 screening levels for dibenzofuran, 1,2,3-trichlorobenzene, 1-methylnaphthalene, 2-methylnaphthalene, benzoic acid, or p-isopropyltoluene. None of the detections of acenaphthene, anthracene, BEHP, fluoranthene, fluorene, phenanthrene, or pyrene exceeded the NMED DAF 1 screening levels. Naphthalene was the only SVOC that was identified as a COPC for SWMU 154 and that had detections that exceeded the DAF 1 screening criterion in one or more soil samples, as shown on Figure 6.21-3.

Naphthalene detections exceeding the NMED DAF 1 screening value (0.00419 mg/kg) were observed at 142B2 (19, 21, 23, and 27 ft bgs), 142B3 (19, 23, 25, 29, 35, and

39 ft bgs), SB8/CFW-02 (13 to 15, 23 to 25, 28 to 30, 33 to 35, 38 to 40, and 53 to 55 ft bgs), SB7/CFW-03 (18 to 20, 38 to 40, and 43 to 45 ft bgs), DRW-01 (30 ft bgs), DRW-02 (30 and 40 ft bgs), DRW-07 (52 to 54 ft bgs), DRW-13 (16 to 18 ft bgs), HLSF-SB-011 (20 to 21, 40 to 42, and 49 to 50 ft bgs), HLSF-SB-013 (40 to 41 and 49 to 50 ft bgs), HLSF-SB-019 (36 to 37 ft bgs), and HMW-13 (15 and 20 ft bgs). No naphthalene detections were observed in shallow soils (• 10 ft bgs) and no naphthalene DAF 1 exceedances (>10 ft bgs) were observed in deeper soils beneath the 142B2, SB8/CFW-02, SB7/CFW-03, DRW-01, DRW-02, DRW-13, HLSF-SB-019, and HMW-13, exceedances, indicating vertical delineation at these locations. Detections of naphthalene are primarily concentrated in the area of the HCF with two isolated detections (HLSF-SB-017 and HMW-13) south of SWMU 154. The naphthalene exceedances in soil samples collected from 142B3 (39 to 40 ft bgs), DRW-07 (52 to 54 ft bgs), HLSF-SB-011 (40 to 42 and 49 to 50 ft bgs), and HLSF-SB-013 (40 to 41 and 49 to 50 ft bgs) most likely occur in saturated soils (approximate depth to water 40 to 45 ft bgs) and has, therefore, been delineated vertically in the soil column at this locations. (53 to 55 ft bgs.) Lateral delineation of naphthalene in deep soils in the area is shown on Figure G-16 in Appendix G ~~-16on Figure G-16 in Appendix G~~. Naphthalene exceedances of NMED groundwater tapwater standards have been detected in surrounding Vadose Zone Wells CFW-01, CFW-04, DRW-01, DRW-02, DRW-03, DRW-05, HCF-01, HCF-02, HCF-03, HCF-05, and HCF-07 (Table 6-2~~12-1~~), which is indicative of a release and transport in the area of SWMU 154. However, no naphthalene impacts to Regional Aquifer wells (HMW-54, HMW-55, and DRW-15) downgradient of SWMU 154 were observed (Table 6-23). Naphthalene is considered a COPC that is indicative of a release associated with the SWMU 154 diesel spill.

~~6.21.5.1.3~~6.21.5.1.6 Other Parameters

6.21.5.1.7 TPH in Shallow Soil (0 – 10ft bgs)

TPH was detected in only three~~wo~~ shallow soil samples. TPH were detected at 2,600 mg/kg at HCF-01 (4 to 6 ft bgs), 2,100 mg/kg at HCF-02 (0 to 5 ft bgs), and 55 mg/kg at HMW-10 (10 ft bgs). TPH are considered COPCs associated with the diesel spill at SWMU 154. Samples that were tested for TPH were also tested for full suites of VOCs and SVOCs that would comprise the TPH. No ~~other~~ VOCs were detected in shallow soil above comparative criteria, and ~~. N~~no SVOCs were detected in shallow soil samples. These conditions confirm that TPH is not a risk to potential receptors.

6.21.5.1.8 TPH in Deep Soil (Greater than10ft bgs)

TPH were detected in 102 deep soil samples (>10 ft bgs). The maximum TPH concentration (19,000 mg/kg) was detected in the 35 to 40 ft sample from HCF-W100. In general, the highest concentrations were detected in soil between 30 and 45 ft bgs. TPH is considered a COPC associated with the SWMU 154 diesel spill.

6.21.5.2 *Metals*

6.21.5.2.1 Metals in Shallow Soil (0 to 10ft bgs)

~~Of the 22 sample locations evaluated for shallow soil (• 10 ft bgs), three~~Four metals (antimony, arsenic, ~~and~~ iron, and manganese) were detected above regulatory limits in shallow soil at SWMU 154. As described under Section 4.3.6 (page 44), arsenic, iron, and manganese detections are attributed to redox conditions ~~naturally occurring conditions~~ existing at the HELSTF and, therefore, arsenic, iron, and manganese are not considered COPCs associated with SWMU 154. ~~Metal exceedances of regulatory standards are shown on Figure 6.21-4.~~

No metals were detected in shallow soils at SWMU 154 above the NMED SSLs for residential soil. ~~No antimony detection exceeded the NMED SSL (31.3 mg/kg). However, d~~Detections of antimony exceed~~ed~~ing the NMED DAF 1 screening value of 0.661 mg/kg ~~were observed~~ at DRW-03 (10 ft bgs), DRW-04 (10 ft bgs), and DRW-05 (10 ft bgs). The maximum antimony detection was 0.980 mg/kg, detected at DRW-03 at a depth of 10 ft bgs. These DAF 1 exceedances have been delineated vertically at all three locations. Detections of antimony appear to be localized in shallow soils at these locations because no detections of antimony were detected in surrounding borings. Antimony occurrences in shallow soil at SWMU 154 are shown on Figure 6.21-4. The lateral delineation of antimony in shallow soils at the HELSTF is shown on Figure G-17 in Appendix G~~-17.on Figure G-17 in Appendix G.~~

6.21.5.2.2 Metals in Deep Soil (Greater than 10ft bgs)

Aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, hexavalent chromium, cobalt, copper, iron, lead magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, titanium, total cyanide, vanadium, and zinc were detected in deep soils at SWMU 154. As described under Section 4.3.6 (page 44), aluminum, arsenic, barium, calcium, cobalt, iron, magnesium, manganese, nickel, potassium, selenium, sodium, titanium, and vanadium detections

are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 154. There are no DAF 1 standards for calcium, chromium, lead, magnesium, potassium, sodium, titanium, or total cyanide. The metals that were identified as COPCs and that were detected in one or more soil samples at concentrations exceeding the DAF 1 screening criteria in deep soil at SWMU 154 were antimony, cadmium, hexavalent chromium, mobydenum, and silver, as shown on Figure 6.21-4.

Detections of antimony exceeding the NMED DAF 1 (0.661 mg/kg) were observed at DRW-04 (20 ft bgs), HCF-NE100 (35 to 40 ft bgs and 40 to 45 ft bgs), HCF-NE200 (20 to 25 ft bgs), and N100 (15 to 20 ft bgs). The maximum detection of antimony was 24.0 mg/kg, detected at N100 at a depth of 15 to 20 ft bgs. All of these antimony exceedances of the DAF 1 criterion have been delineated laterally and vertically at these locations. The lateral delineation of antimony in deep soils at the HELSTF is shown on Figure G-18 in Appendix G~~-18.on Figure G-18 in Appendix G.~~

A single cadmium detection of 2.0 mg/kg exceeded the NMED DAF 1 (1.37 mg/kg) at HCF-01 (19 to 20 ft bgs). This is an isolated exceedance of the DAF 1 criterion for cadmium that has been delineated vertically and laterally. The lateral delineation of cadmium in deep soils at the HELSTF is shown on Figure G-~~1~~9 in Appendix G~~-19.on Figure G-19 in Appendix G.~~

Hexavalent chromium detections exceeding the NMED DAF 1 (2.1 mg/kg) were observed at CFW-02 (43 to 45, 48 to 50, 53 to 55, and 58 to 60 ft bgs) and at HLSF-SB-015 (20 to 21 ft bgs). The maximum detection of hexavalent chromium was 18.0 mg/kg, detected at CFW-02 at a depth of 43 to 45 ft bgs. All of the hexavalent chromium exceedances in soil from CFW-02 were likely located in saturated soils (depth to first water in the area is 40 to 45 ft bgs) and are attributable to the commingled impacts to vadose zone water from the Cleaning Facility Sump (SWMU 142). Hexavalent chromium would not be an expected COPC associated with the diesel spill. The exceedance of the DAF 1 criterion for hexavalent chromium at HLSF-SB-015 has been delineated laterally and vertically at this location. The lateral delineation of hexavalent chromium in deep soils at the HELSTF is shown on Figure G-10 in Appendix G~~-10.on Figure G-10 in Appendix G.~~

A single molybdenum detection exceeding the NMED DAF 1 screening value (3.7 mg/kg) was observed at 25.0 mg/kg HCF-NE100 (15 to 20 ft bgs). This is an isolated exceedance of the DAF 1 criterion for molybdenum that has been delineated

vertically and laterally. The lateral delineation of molybdenum in deep soils at the HELSTF is shown on Figure G-1920 in Appendix G-20~~on Figure G-20 in Appendix G.~~

Detections of -silver exceeding the NMED DAF 1 (1.57 mg/kg) were observed at HCF-02 (10 to 15 and 15 to 20 ft bgs) and at HCF-S100 (12 to 13.5 ft bgs). The maximum detection of silver was 5.40 mg/kg, detected at HCF-02 at a depth of 10 to 15 ft bgs. These exceedances of the DAF 1 criterion for silver have been delineated vertically and laterally. The lateral delineation of silver in deep soils at the HELSF is shown on Figure G-3 in Appendix G-3~~on Figure G-3 in Appendix G.~~

6.21.5.3 ~~*Shallow Soil*~~ *Summary*

~~In summary, COPCs were detected in shallow soils at SWMU 154. These include the SVOCs 1,2,4-TMB and 1,3,5-TMB and the metal antimony, all of which exceeded NMED DAF 1 screening levels. In addition, TPH was detected in nearby sampling locations and is considered a COPC associated with the SWMU 154 diesel spill.~~ No VOCs or metals were detected above the NMED SSLs for residential soil in shallow soil at SMWU 154, and no VOCs were detected above the DAF 1 criteria in shallow soil. Antimony was detected in shallow soil above its DAF 1 screening criterion. No SVOCs were detected in shallow soil at SMWU 154. TPH were detected in only three shallow soil samples in the SWMU 154 release area.

6.21.5.4 *The only VOCs associated with the release at SWMU 154 and detected at concentrations exceeding the DAF 1 values in deep soil at SWMU 154 were benzene, ethylbenzene, isopropylbenzene and xylenes, and the only SVOC detected above the DAF 1 screening criteria was naphthalene. Elevated TPH were detected in deep soil throughout the SWMU 154 release area. The metals antimony, cadmium, hexavalent chromium, molybdenum, and silver were detected above their respective DAF 1 criteria in deep soils in the SMWU 154 release area. The VOCs, SVOCs, and TPH are indicative of a diesel release from SWMU 154. All of the DAF 1 exceedances have been delineated laterally and vertically. Some of these constituents have also been detected in vadose zone water. However, none of the COPCs associated with SWMU 154 were detected in downgradient regional groundwater.* ~~*Deep Soil (Greater than 10 ft bgs)*~~

~~6.21.5.4.1 There were 43 soil sample locations evaluated for soils greater than 10 ft bgs. There were 25 VOC detections, 6 SVOC detections, and 11 metal detections above NMED DAF 1 screening values. Table 6.21-3 provides a statistical summary of data for deep soil and Table 6.21-4 provides a summary of exceedances of regulatory standards for deep soil at SWMU 154.VOCs~~

~~VOC detections included the following: 1,1,1-TCA, 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113), 1,1,2,2-tetrachloroethane, 1,1-DCA, 1,1-DCE, 1,2-dichloroethane, 2-butanone, acetone, benzene, bromomethane, carbon disulfide, carbon tetrachloride, chloroethane, chloroform, chloromethane, dibromochloromethane, ethylbenzene, isopropylbenzene, m,p-xylene, methylene chloride, naphthalene, n-butylbenzene, n-propylbenzene, o-xylene, sec-butylbenzene, tetrachloroethene, toluene, trichloroethene, trichlorofluoromethane, vinyl chloride, and total xylenes. Of these, 1,1,1-TCA, CFC-113, 1,1,2,2-tetrachloroethane, 1,1-DCA, 1,1-DCE, 1,2-dichloroethane, 2-butanone, acetone, bromomethane, carbon disulfide, carbon tetrachloride, chloroethane, chloroform, chloromethane, dibromochloromethane, methylene chloride, tetrachloroethene, toluene, trichlorofluoromethane, trichloroethene, and vinyl chloride are solvent related VOCs that are not considered COPCs associated with SWMU 154, but are a result of the commingled release from nearby SWMU 142, which is addressed in Section 6.12 (page 157).~~

~~Detections of benzene exceeding the NMED DAF 1 screening value of 0.001 mg/kg were observed at the following locations: 142B2 (19, 21, 23, and 27 ft bgs), 142B3 (23, 25, 29, 35, and 39 ft bgs), CFW-01 (39 and 41 ft bgs), CFW-02 (23 to 25 ft bgs, 33 to 35 ft bgs, and 53 to 55 ft bgs), CFW-03 (18 to 20 and 38 to 40 ft bgs), DRW-02 (40 ft bgs), HCF-02 (25 to 30, 35 to 40, and 40 to 45 ft bgs), HCF-03 (25 to 30, 35 to 40, and 40 to 45 ft bgs), HCF-NE100 (20 to 25 and 60 ft bgs), HCF-NE200~~

~~(20 to 25 ft bgs), HCF-SW100 (70 ft bgs), HCF-W100 (70 ft bgs), HLSF-SB-011 (40 to 42 ft bgs), HMW-13 (20 ft bgs), N100 (20 to 25, 25 to 30, and 70 ft bgs), N200 (60 ft bgs), SB7 (18 to 20 and 38 to 40 ft bgs), SB8 (23 to 25 and 53 to 55 ft bgs), and SE-100 (14.5 to 16, 19.5 to 21, 24.5 to 26, 29.5 to 31, and 44.5 to 46 ft bgs).~~

~~The maximum detection of benzene was 1.4 mg/kg, detected at DRW-02 at 40 ft bgs. All detections of benzene occurred in deep soils (>10 ft bgs) and are primarily concentrated in the area of the HCF with isolated detections to the south and southeast of SWMU 154. Benzene exceedances are laterally delineated as shown on the map in Appendix G (G-11). DAF 1 exceedances at 142B2, CFW-01, CFW-02, CFW-03, DRW-02, HCF-02, HCF-03 HLSF-SB-011, HMW-13, SB7, and SB8 are delineated vertically because there are no detected exceedances in deeper soils. DAF 1 exceedances in 142B3, HCF-NE100, HCF-SW100, HCF-W100, N100, N200, and SE100 most likely occur in saturated soils (approximate depth to water 40 to 45 ft bgs) and have, therefore, been delineated vertically in the soil column at these locations. Benzene exceedances in the vadose zone water were observed at Wells DRW-01, DRW-02, DRW-03, DRW-04, DRW-05, HCF-02, HCF-03, HCF-05, and HCF-07; however, no benzene detections were observed in the Regional Aquifer. Benzene is considered a COPC resulting from the diesel release associated with SWMU 154.~~

~~Detections of ethylbenzene exceeding the NMED DAF 1 (1.01 mg/kg) were observed at 142B3 (25 and 35 ft bgs), CFW-01 (42 ft bgs), DRW-02 (30 ft bgs), HCF-02 (25 to 30 and 35 to 40 ft bgs), HCF-03 (25 to 30 and 35 to 40 ft bgs), HCF-NE100 (20 to 25 and 40 to 45 ft bgs), and N100 (25 to 30 ft bgs) as shown in Appendix G. No detections of ethylbenzene occurred in soils less than 10 ft bgs and DAF 1 exceedances (soils >10 ft bgs) are considered vertically delineated because no exceedances in soils were observed at greater depths. In addition, no detections of ethylbenzene were observed in vadose zone groundwater. All detections of ethylbenzene are primarily concentrated in the area of the HCF with an isolated detection (HCF-03) south of SWMU 154. Ethylbenzene exceedances are laterally delineated as shown on Figure G-12 in Appendix G. Additional detections, below regulatory screening levels, were observed at 142B3, CFW-01, CFW-02, CFW-03, DRW-01, DRW-02, HCF-02, HCF-03, HCF-NE100, HCF-S100, HCF-SW100, HCF-W100, HLSF-SB-011, N100, and SB8. The maximum ethylbenzene detection was 5.70 mg/kg, detected at HCF-02 and HCF-03, both at 25 to 30 ft bgs. Ethylbenzene is considered a COPC resulting from the diesel release associated with SWMU 154.~~

An isopropylbenzene detection exceeding the NMED DAF 1 screening value (4.1 mg/kg) was observed at DRW-02 (40 ft bgs). The maximum detection of isopropylbenzene was 5.00 mg/kg observed in DRW-02 at 40 ft bgs. No exceedances were observed in soils greater than 40 ft bgs or in surrounding sample locations indicating vertical and lateral delineation at DRW-02 as shown on the map in Appendix G (G-13). Additional detections were observed at DRW-01, DRW-02, DRW-13, HLSF-SB-011, HLSF-SB-013, and HLSF-SB-019, but all were below regulatory screening levels. Isopropylbenzene is considered a COPC that is indicative of a release associated with the SWMU 154 diesel spill.

Detections of m,p-xylene exceeding the NMED DAF 1 (0.103 mg/kg) were observed at DRW-01 (30 ft bgs), DRW-02 (30 and 40 ft bgs), HCF-02 (15 to 20 and 35 to 40 ft bgs), HCF-03 (15 to 20 ft bgs), HCF-NE100 (20 to 25 ft bgs), HCF-NE200 (20 to 25 ft bgs), HCF-SW100 (25 to 30 ft bgs), HCF-W100 (35 to 40 ft bgs), and N100 (20 to 25 and 25 to 30 ft bgs). No m,p-xylene DAF 1 exceedances were observed in soils deeper than the above-referenced sample locations or in surrounding borings indicating vertical and lateral delineation. All detections of m,p xylene are primarily concentrated in the area of the HCF with two isolated detections (HCF-03 and HCF-SW100) south of SWMU 154 as shown on Figure G-13 in Appendix G. Additional detections were observed at HCF-02, HCF-W100, HLSF-SB-011, HLSF-SB-19, N100, and SE-100, but all were below regulatory screening levels. M,p-xylene is considered a COPC that is indicative of a release associated with the SWMU 154 diesel spill.

Naphthalene detections exceeding the NMED DAF 1 screening value (0.0197 mg/kg) were observed at 142B2 (19, 21, 23, and 27 ft bgs), 142B3 (19, 23, 25, 29, 35, and 39 ft bgs), CFW-02 (13 to 15, 23 to 25, 28 to 30, 33 to 35, 38 to 40, and 53 to 55 ft bgs), CFW-03 (18 to 20, 38 to 40, and 43 to 45 ft bgs), DRW-01 (30 ft bgs), DRW-02 (30 and 40 ft bgs), DRW-13 (16 to 18 ft bgs), HLSF-SB-011 (20 to 21, 40 to 42, and 49 to 50 ft bgs), HLSF-SB-013 (40 to 41 and 49 to 50 ft bgs), HLSF-SB-019 (36 to 37 ft bgs), HMW-13 (15 and 20 ft bgs), SB7 (38 to 40 ft bgs), and SB8 (13 to 15,23 to 25, 28 to 30, 33 to 35, and 53 to 55 ft bgs). No naphthalene detections were observed in shallow soils (• 10 ft bgs) and no naphthalene DAF 1 exceedances (>10 ft bgs) in soils beneath the 142B2, CFW-02, CFW-03, DRW-01, DRW-02, DRW-13, HLSF-SB-019, HMW-13, SB7, or SB8 observed exceedances indicating vertical delineation. Detections of naphthalene are primarily concentrated in the area of the HCF with two isolated detections (HLSF-SB-017 and HMW-13) south of SWMU 154. Lateral delineation in the area is shown on Figure G-14 in Appendix G. DAF 1 exceedances in 142B3, HLSF-SB-011, and HLSF-SB-013 most likely occur in saturated soils (approximate depth to water 40 to 45 ft bgs) and have, therefore, been

delineated vertically in the soil column at these locations. Naphthalene exceedances of NMED groundwater tapwater standards have been detected in surrounding Vadose Zone Wells CFW-01, CFW-04, DRW-01, DRW-02, DRW-03, DRW-05, HCF-01, HCF-02, HCF-03, HCF-05, and HCF-07 (Table 1 of Appendix D-3), which is indicative of a release and transport in the area of SWMU 154. However, no impacts to Regional Aquifer wells (HMW-42, HMW-54, HMW-55, and DRW-15) downgradient of SWMU 154 were observed. Additional detections were observed at SB7 and DRW-07, but were below regulatory screening levels. Naphthalene is considered a COPC that is indicative of a release associated with the SWMU 154 diesel spill.

Detections of n-butylbenzene exceeding the NMED DAF 1 screening value (0.27 mg/kg) were observed at DRW-01 (30 ft bgs), DRW-02 (30 ft bgs), HLSF-SB-011 (30 to 32 and 40 to 42 ft bgs), HLSF-SB-013 (40 to 41 ft bgs), HLSF-SB-019 (20 to 22, 30 to 31, and 36 to 37 ft bgs). There are no n-butylbenzene exceedances in soils beneath the DRW-01, DRW-02, HLSF-SB-011, HLSF-SB-013, or HLSF-SB-019 observed exceedances or in surrounding borings outside the HCF area indicating vertical and lateral delineation as shown on Figure G-15 in Appendix G. In addition, no exceedances were observed in area vadose zone groundwater wells (Table 1 of Appendix D-3). Additional detections were observed at DRW-13, HLSF-SB-011, and HLSF-SB-013, but were below regulatory screening levels. The maximum detection of n-butylbenzene was 5.50 mg/kg, detected at DRW-02 at 30 ft bgs. N-butylbenzene is considered a COPC that is indicative of a release associated with the SWMU 154 diesel spill.

Detections of n-propylbenzene exceeding the NMED DAF 1 screening value (0.27 mg/kg) were observed at DRW-01 (30 ft bgs), DRW-02 (30 and 40 ft bgs), HLSF-SB-011 (40 to 42 ft bgs), and HLSF-SB-013 (40 to 41 ft bgs). There are no n-propylbenzene exceedances in soils beneath the DRW-01, DRW-02, HLSF-SB-011, or HLSF-SB-013 observed exceedances or in surrounding borings outside the HCF area indicating vertical and lateral delineation as shown on Figure G-16 in Appendix G. In addition, no exceedances were observed in area vadose zone groundwater wells (Table 1 of Appendix D-3). Additional detections were observed at DRW-02, HLSF-SB-011, and HLSF-SB019, but were below regulatory screening levels. The maximum detection of n-propylbenzene was 7.8 mg/kg, detected at DRW-02 at 40 ft bgs. N-propylbenzene is considered a COPC that is indicative of a release associated with the SWMU 154 diesel spill.

A single o-xylene detection exceeding the NMED DAF 1 (4.07 mg/kg) was observed at HCF-NE100 (4.5 mg/kg) at a depth of 20 to 25 ft bgs. There are no o-xylene

exceedances in soils beneath the HCF-NE100 observed exceedance or in surrounding borings indicating vertical and lateral delineation. Additional detections were observed at DRW-01, DRW-02, HCF-02, HCF-03, HCF-NE100, HCF-NE200, HCF-S100, HCF-SW100, HCF-W100, HLSF-SB-011, HLSF-SB-019, N100, and SE100, but all were below regulatory screening levels. O-xylene is considered a COPC that is indicative of a release associated with the SWMU 154 diesel spill.

Sec-butylbenzene detections exceeding the NMED DAF 1 screening value (0.217 mg/kg) were observed at DRW-01 (30 ft bgs), DRW-02 (30 and 40 ft bgs), DRW-13 (16 to 18 ft bgs), HLSF-SB-011 (30 to 32 and 40 to 42 ft bgs), HLSF-SB-013 (40 to 41 ft bgs), and HLSF-SB-019 (20 to 22, 30 to 31, and 36 to 37 ft bgs). There are no sec-butylbenzene exceedances in soils beneath the DRW-01, DRW-02, DRW-13, HLSF-SB-011, HLSF-SB-013, or HLSF-SB-019 observed exceedances or in surrounding borings outside the HCF area indicating vertical and lateral delineation. Detections of sec-butylbenzene are primarily concentrated in the area of the HCF with an isolated detection (DRW-13) west of SWMU 154 as shown on Figure G-17 in Appendix G. Additional detections were observed at DRW-01, DRW-02, HLSF-SB-011, and HLSF-SB-013, but all were below regulatory screening levels. The maximum sec-butylbenzene detection was 6.10 mg/kg, detected at DRW-02 at 40 ft bgs. Sec-butylbenzene is considered a COPC that is indicative of a release associated with the SWMU 154 diesel spill.

6.21.5.4.2 Total xylene detections exceeding the NMED DAF 1 (0.103 mg/kg) were observed at 142B2 (19, 23, and 27 ft bgs), 142B3 (23, 25, 29, 35, and 39 ft bgs), CFW-01 (49 and 53 ft bgs), CFW-02 (53 to 55 ft bgs), CFW-03 (18 to 20, 23 to 25, and 38 to 40 ft bgs), HMW-13 (15 and 20 ft bgs), SB7 (18 to 20 and 23 to 25 ft bgs), and SB8 (53 to 55 ft bgs). There are no total xylene exceedances in soils beneath the 142B2, CFW-01, CFW-02, CFW-03, HMW-13, SB7, and SB8 observed exceedances or in surrounding borings outside the HCF indicating vertical and lateral delineation. Detections of xylenes are primarily concentrated in the area of the HCF with an isolated detection (HMW-13) south of SWMU 154 as shown on Figure G-18 in Appendix G. The DAF 1 exceedance in 142B3 (39 ft bgs) most likely occurred above saturated soils (approximate depth to water 45 to 47 ft bgs); however, no samples were collected below this depth. There appears to be no vadose zone xylene impacts in nearby wells (DRW-01, DRW-02, DRW-03, and HCF-01). Additional detections were observed at 142B2, CFW-01, CFW-02, N100, and SB8, but all were below regulatory screening levels. Total xylenes are considered COPCs that are indicative of a release associated with the SWMU 154 diesel spill.SVOCs

SVOC detections included the following: 1,2,3-trichlorobenzene, 1,2,4-TMB, 1,3,5-TMB, 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, anthracene, benzoic acid, BEHP, dibenzofuran, diphenylamine, fluoranthene, fluorene,

n-nitrosodiphenylamine, phenanthrene, p-isopropyl toluene, and pyrene. As indicated in Table 6.1-1, diphenylamine and N-nitrosodiphenylamine are not COPCs associated with wastes generated at the HELSTF. There are no DAF 1 screening levels for 1,2,3-trichlorobenzene, 1-methylnaphthalene, 2-methylnaphthalene, benzoic acid, or p-isopropyltoluene. None of the detections of anthracene, BEHP, fluoranthene, phenanthrene, or pyrene exceeded the NMED DAF 1 screening levels.

1,2,4-TMB detections exceeding the NMED DAF 1 screening value (0.0709 mg/kg) were observed at DRW-01 (30 ft bgs), DRW-02 (20, 30, and 40 ft bgs), HLSF-SB-011 (20 to 21, 30 to 32, and 40 to 42 ft bgs), HLSF-SB-013 (40 to 41 ft bgs), and HLSF-SB-019 (30 to 31 ft bgs). There are no 1,2,4-TMB exceedances in soils beneath the DRW-01, DRW-02, HLSF-SB-011, HLSF-SB-013, and HLSF-SB-019 observed exceedances or in surrounding borings outside the HCF area indicating vertical and lateral delineation. Detections of 1,2,4-TMB are concentrated in the area of the HCF as shown on Figure G-19 in Appendix G. Additional detections were observed at HLSF-SB-011 and HLSF-SB-013, but were below regulatory levels. The maximum detection of 1,2,4-TMB was 32.0 mg/kg, detected at DRW-02 at a depth of 40 ft bgs. 1,2,4-TMB is considered a COPC that is indicative of a release associated with the SWMU 154 diesel spill.

1,3,5-TMB detections exceeding the NMED DAF 1 (0.0177 mg/kg) were observed at DRW-01 (30 ft bgs), DRW-02 (40 ft bgs), HLSF-SB-011 (20 to 21, 30 to 32, and 40 to 42 ft bgs), HLSF-SB-013 (40 to 41 ft bgs), and HLSF-SB-019 (30 to 31 ft bgs). There are no 1,3,5-TMB exceedances in soils beneath the DRW-01, DRW-02, HLSF-SB-011, HLSF-SB-013, and HLSF-SB-019 observed exceedances or in surrounding borings indicating vertical and lateral delineations as shown on Figure G-20 in Appendix G. 1,3,5-TMB is considered a COPC that is indicative of a release associated with the SWMU 154 diesel spill.

Two acenaphthene detections exceeding the NMED DAF 1 screening value (2.75 mg/kg) were observed at HLSF-SB-011 (40 to 42 ft bgs) and SB8 (23 to 25 ft bgs). There are no acenaphthene exceedances in soils beneath the HLSF-SB-011 and SB8 observed exceedances or in surrounding borings indicating vertical and lateral delineation as shown on Figure G-21 in Appendix G. Detections below regulatory screening levels were observed at CFW-02, CFW-03, HLSF-SB-011, HLSF-SB-019, and SB8. The maximum detection for acenaphthene was 4.6 mg/kg, at SB8 (23 to 25 ft/bgs). Acenaphthene is considered a COPC that is indicative of a release associated with the SWMU 154 diesel spill.

~~Dibenzofuran detections exceeding the NMED DAF 1 (0.144 mg/kg) were observed at CFW-02 (13 to 15, 23 to 25, 28 to 30, 33 to 35, 38 to 40, and 53 to 55 ft bgs), CFW-03 (18 to 20 and 38 to 40 ft bgs), HLSF-SB-011 (20 to 21 and 30 to 32 [duplicate] ft bgs), HLSF-SB-013 (40 to 41 ft bgs), HLSF-SB-019 (20 to 22 and 30 to 31 ft bgs), SB7 (38 to 40 ft bgs), and SB8 (13 to 15, 23 to 25, 28 to 30, 33 to 35, and 53 to 55 ft bgs). No detections of dibenzofuran were observed in shallow soils (• 10 ft bgs) and no exceedances in soils beneath the CFW-02, CFW-03, HLSF-SB-011, HLSF-SB-013, and HLSF-SB-019 observed exceedances or in surrounding borings outside the HCF area indicating vertical and lateral delineation as shown on Figure G-22 in Appendix G. Detections of dibenzofuran are primarily concentrated in the area of the HCF with an isolated detection (HLSF-SB-017) southeast of SWMU 154. Dibenzofuran exceedances of NMED Tapwater standards (12.2 µg/L) have been detected in surrounding Vadose Zone Wells DRW-01, DRW-02, DRW-03, DRW-04, HCF-03, HCF-05, and HCF-07 (Section 6.25 [page 287] and Table 1 of Appendix D-3), which is indicative of a release and transport from soils to groundwater. However, no dibenzofuran impacts to the Regional Aquifer were detected (Table 2 of Appendix D-3). A single detection in soils below regulatory screening levels was observed at CFW-03. The maximum detection of dibenzofuran was 5.30 mg/kg, detected at CFW-02 and SB8 at depths of 13 to 15 ft bgs. Dibenzofuran is considered a COPC that is indicative of a release associated with the SWMU 154 diesel spill.~~

6.21.5.4.3 Fluorene detections exceeding the NMED DAF 1 value (2.93 mg/kg) were observed at CFW-02 (13 to 15, 23 to 25, 33 to 35, and 53 to 55 ft bgs), CFW-03 (38 to 40 ft bgs), HLSF-SB-011 (40 to 42 ft bgs), SB7 (38 to 40 ft bgs), and SB8 (13 to 15, 23 to 25, 33 to 35, and 53 to 55 ft bgs). No detections of fluorene were observed in shallow soils (• 10 ft bgs) and no exceedances in soils beneath the CFW-02, CFW-03, HLSF-SB-011, SB7, or SB8 observed exceedances or in surrounding borings outside of the HCF area indicating vertical and lateral delineation as shown on Figure G-23 in Appendix G. Detections were observed at 142B2, 142B3, CFW-02, CFW-03, HLSF-SB-011, HLSF-SB-013, HLSF-SB-019, and HMW-13, but were below regulatory screening levels. Fluorene exceedances of NMED Tapwater standards (243 µg/L) have been detected in adjacent Vadose Zone Wells DRW-02, DRW-03, and HCF-05 (Section 6.25 [page 287] and Table 1 of Appendix D-3), which is indicative of a release and transport from soils to groundwater. However, no fluorene impacts to the Regional Aquifer were observed (Table 2 of Appendix D-3). Fluorene is a COPC associated with the SWMU 154 diesel release.Other Parameters

6.21.5.4.4 TPH were detected in 14 deep soil samples (>10 ft bgs). Maximum TPH detections were observed at HLSF-SB-011 (DRO – 10,800 mg/kg and GRO – 386 mg/kg), DRW-02 (C10-C28 – 18,000 mg/kg), and 142B3 (petroleum hydrocarbons – 9,100 mg/kg) (Table 18 of Appendix D-2). The highest concentrations of TPH in the vicinity of SWMU 154 occur at depths of 40 to 42 ft bgs. TPH is considered a COPC associated with the SWMU 154 diesel spill.Metals

Aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, chromium VI, iron, lead magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, titanium, total cyanide, vanadium, and zinc were detected in deep soils at SWMU 154. As described under Section 4.3.6 (page 41), aluminum, arsenic, barium, calcium, cobalt, iron, lead, magnesium, manganese, nickel, potassium, selenium, sodium, titanium, vanadium, and zinc detections are attributable to naturally occurring conditions existing at the HELSTF and, therefore, are not considered COPCs associated with SWMU 154. There are no regulatory standards for calcium, magnesium, potassium, sodium, titanium, or total cyanide, and there are no DAF 1 standards for chromium and lead.

Detections of antimony exceeding the NMED DAF 1 (0.661 mg/kg) were observed at DRW-04 (20 ft bgs), HCF-NE100 (35 to 40 ft bgs and 40 to 45 ft bgs), HCF-NE200 (20 to 25 ft bgs), and N100 (15 to 20 ft bgs). Two detections below regulatory screening levels were observed at DRW-03 and DRW-05. The maximum detection of antimony was 24.0 mg/kg, detected at N100 at a depth of 15 to 20 ft bgs.

A single cadmium detection exceeded the NMED DAF 1 (1.37 mg/kg) at HCF-01 (19 to 20 ft bgs). Detections below regulatory screening levels were observed at CFW-01,

~~HCF-01, HCF-S100, HMW-10, and SB7. The maximum detection was 2.0 mg/kg, at HCF-01 (19 to 20 ft bgs).~~

~~Hexavalent chromium detections exceeding the NMED DAF 1 (2.1 mg/kg) were observed at CFW-02 (43 to 45, 48 to 50, 53 to 55, and 58 to 60 ft bgs) and at HLSF-SB-015 (20 to 21 ft bgs). The maximum detection of hexavalent chromium was 18.0 mg/kg, detected at CFW-02 at a depth of 43 to 45 ft bgs.~~

~~A single molybdenum detection exceeding the NMED DAF 1 screening value (3.7 mg/kg) was observed at HCF-NE100. The maximum detection was 25.0 mg/kg, at a depth of 15 to 20 ft bgs.~~

~~Detections of silver exceeding the NMED DAF 1 (1.57 mg/kg) were observed at HCF-02 (10 to 15 and 15 to 20 ft bgs) and at HCF-S100 (12 to 13.5 ft bgs). The maximum detection of silver was 5.40 mg/kg, detected at HCF-02 at a depth of 10 to 15 ft bgs.~~

~~6.21.5.5~~6.21.5.4 ~~*Deep Soil*~~ *Summary*

In summary, several VOCs, SVOCs, TPH, and metals associated with the release from SWMU 154 were detected in deep soils at concentrations exceeding the DAF 1 criteria.~~These constituents have been generally delineated, as shown on the maps in Appendix G. Some of these constituents have also been detected in vadose zone water. However, none of the COPCs associated with SWMU 154 were detected in downgradient regional groundwater.~~

6.21.6 Human Health Risk Assessment Findings

Data collected during site characterization activities during the RFIs were used in the evaluation of risk to human health. A description of risk assessment methodologies and results is provided on page 280~~270~~ of Appendix E.

~~6.21.6.1 *Soil Exposure Scenarios*~~

~~In accordance with NMED guidance (NMED, 2006a), constituent concentrations in surface soil and in combined surface and subsurface soil were compared to health-based screening levels and the calculated ratios summed. The total ratios were less than the NMED target ratio of 1. The results of this data screening process indicate that after comparison to health based soil screening levels for industrial worker~~

exposure, residential exposure, and construction worker exposure, no COPCs were selected for surface soil or for combined surface and subsurface soil at SWMU 154. This demonstrates that the constituent concentrations in surface soil and in combined surface and subsurface soil at SWMU 154 are unlikely to result in adverse health impacts to the following potential receptors via direct contact exposure (i.e., ingestion, inhalation of vapor/dust, dermal):

- Current and future site workers;
- Future residents (adults and children); and
- Future construction workers.

6.21.6.2 *Vapor Intrusion Scenarios*

All detected volatile constituents in total soil (i.e., vadose zone) were selected as COPCs for the future vapor intrusion evaluation because there are no NMED or USEPA soil screening levels that are protective of the vapor intrusion pathway. All detected volatile constituents in saturated vadose zone soil water were compared to the USEPA (2002a) groundwater screening levels for the protection of indoor air and the calculated ratios summed. The total ratios were above the NMED target ratio of 1.

The total ELCR value for the future vapor intrusion exposure pathway for the site worker scenario is within the acceptable target risk range of 10^{-6} to 10^{-4} for carcinogenic effects. The total HI value for the future vapor intrusion exposure pathway for the site worker scenario is above the benchmark of 1 for non-cancer hazard. When the HI for a site worker exposure to indoor air is segregated by target site and critical effects, none of the hazards are above the benchmark of 1, indicating adverse non-carcinogenic effects are unlikely to occur.

The total ELCR value for the vapor intrusion exposure pathway for a hypothetical future age-adjusted resident (0 to 30 years) is above the acceptable target risk range of 10^{-6} to 10^{-4} for carcinogenic effects. The total HI value for the vapor intrusion exposure pathway for a hypothetical future child resident scenario is above the benchmark of 1. When the HI for a hypothetical future child resident exposure to indoor air is segregated by target site and critical effects, the HI for nasal and lung and the HI for unidentified target organ are above the benchmark of 1.

~~6.21.6.3 *Overall Human Health Risk Assessment Summary*~~

The HHRA for SWMU 154 indicates that current and future industrial use of the site would result in potential exposures that are within or below the regulatory benchmarks for cancer risks and non-cancer hazards. The evaluation also indicates that potential future residential redevelopment of the site may result in potential exposures to indoor air that are above the regulatory benchmarks for cancer risks and non-cancer hazards if all exposure assumptions are met.

It is important to reiterate that the scenarios for which unacceptable risks and/or hazards were calculated are all hypothetical future scenarios. There are no unacceptable risks and/or hazards to current receptors (i.e., site workers) at SWMU 154. The unacceptable risks and hazards were calculated for unlikely future scenarios using highly conservative exposure assumptions. Therefore, the potential for COPCs at SWMU 154 to represent a significant concern in the future is considered low, and additional evaluation is considered unnecessary.

6.21.7 Ecological Risk Assessment Findings

As described within the ERA presented on page 282~~271~~ of Appendix E, a SLERA and BERA were completed for SWMU 154. After the SLERA, nine constituents were selected as COPECs in combined surface and subsurface soil because the HQs were greater than one. However, when these COPECs were considered in combination with their frequency of detection, areal extent of exceedances, and the basis for their ESLs, adverse impacts are not expected for terrestrial wildlife potentially exposed to sec-butylbenzene, ethylbenzene, isopropylbenzene, n-propylbenzene, 1,2,4-TMB, 1,3,5-TMB, antimony, lead, and vanadium in surface and subsurface soil at SWMU 154.

6.21.8 Conclusions and Recommendations

Releases to soil and groundwater have occurred at SWMU 154. The site has been adequately characterized. A detailed discussion regarding the groundwater conditions at SWMU 154 are provided under Section 6.25 (page 351).

There are no unacceptable risks and/or hazards to current receptors (i.e., site workers) at SWMU 154. However, potential future residential development of the site may result in potential indoor air exposures that are above the regulatory benchmarks for cancer risks and non-cancer hazards. It is important to reiterate that the scenarios for which

unacceptable risks and/or hazards were calculated are all hypothetical future scenarios. Due to the very low frequency of detection and limited spatial extent in combination with the unlikely potential for future exposure (i.e., it is unlikely that the site will be re-developed as a residential property in the future), the concern is low and additional evaluation is not necessary.

A SLERA and BERA were completed for SWMU 154 to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents detected in surface soil and subsurface soil. The results of the SLERA and BERA for direct contact exposure indicate there is adequate information to conclude that adverse impacts are unlikely to occur for ecological receptors potentially exposed to constituents in soil. Therefore, no further ecological evaluation at SWMU 154 is warranted.

Based upon the results of the RFI and risk assessment, conditions at SWMU 154 will be addressed as part of a long-term groundwater monitoring program.

6.22 AOC-N – Process Spills at the HELSTF

6.22.1 Unit Description

The~~e~~is area is not a specific unit as described within the initial 1988 RFA report prepared by A.T. Kearney. A.T. Kearney described this AOC as spills resulting from laser-optic-related manufacturing activities. During the process-related activities, mirrors made of molybdenum were cooled using high-pressure water. The water contained chromium to prevent corrosive bacterial growth. The recirculating cooling water was bled off and make-up water was periodically added to the cooling system.

6.22.2 Operational History

In the 1988 RFA, A.T. Kearney reported that a release occurred on June 12, 1986. The release resulted due to operator error, and involved approximately 1,750 gallons of cooling water containing hexavalent chromium. A.T. Kearney also reported that all soil containing greater than 5 ppm chromium was removed and contained for off-site disposal. No documentation for this event or response was available for review. According to the RFA, the chromate-contaminated soil was placed in the ~~HELSTF Construction~~ HELSTF Landfills (SWMUs 38 and 39).

6.22.3 Regulatory History

The 1988 RFI concluded that NFA for this unit was warranted. The release that was reported on June 12, 1986, *was either cleaned up or of a minor quantity* (A.T. Kearney, 1988). The SWMU was subsequently listed in the RCRA Permit as an Appendix III site. It was not included in the Phase I RFI~~ for an unknown reason~~. It has remained as a non-billable corrective action unit during the Annual Unit Audits (WTS, 2006). The facility's current (2009) RCRA permit lists AOC N as a SWMU with corrective action complete without controls (NMED 2009). Therefore, the AOC is eligible for NFA and removal from the permit.

6.22.4 Investigative History

No investigations have been conducted at this unit. As proposed within the Phase III RFI Work Plan, data collected during the Phase III RFI at the locations of SWMUs 25, 27~~ through 30~~, 141, 143, and 146 are comprehensive enough to address various spills from unknown locations within these nearby areas (WTS, 2006).

6.22.5 Nature and Extent of Contamination

The area is not a specific unit as described within the initial 1988 RFA report prepared by A.T. Kearney. Based upon this condition, the nature and extent of contamination could not specifically be determined. However, as proposed under the Phase III RFI Work Plan, assessment of this location would be covered as part of the investigations for SWMUs 25, 27~~ through 30~~, 141, 143, and 146. The discussions for nature and extent for these SWMUs are addressed under Sections 6.3.5 (page 112), 6.5.5 (page 135), 6.11.5 (page 182), 6.13.5 (page 222), and 6.16.5 (page 262).

6.22.6 Human Health Risk Assessment Findings

The area is not a specific unit as described within the initial 1988 RFA report prepared by A.T. Kearney. Based upon this condition, a risk assessment could not specifically be conducted for this AOC. However, as proposed under the 2006 Phase III RFI Work Plan, assessment of this location would be covered as part of the investigations for SWMUs 25, 27 through 30, 141, 143, and 146. The results of HHRAs for these SWMUs are addressed under Sections 6.3.6 (page 117), 6.5.6 (page 140), 6.11.6 (page 187), 6.13.6 (page 227), and 6.16.6 (page 265).

6.22.7 Ecological Risk Assessment Findings

The area is not a specific unit as described within the initial 1988 RFA report prepared by A.T. Kearney. Based upon this condition, a risk assessment could not specifically be conducted for this AOC. However, as proposed under the Phase III RFI Work Plan, assessment of this location would be covered as part of the investigations for SWMUs 25, 27 through 30, 141, 143, and 146. The results of ERAs for these SWMUs are addressed under Sections 6.3.7 (page 118), 6.5.7 (page 143), 6.11.7 (page 188), 6.13.7 (page 230), and 6.16.7 (page 266).

6.22.8 Conclusions and Recommendations

Because this AOC is not a specific area, and because ~~related~~other releases at the HELSTF are being addressed under the RFI process~~for SWMUs 25, 27 30, 141, 143, and 146~~, no further assessment of conditions for this AOC are proposed. In addition, AOC N is shown on the current RCRA permit as an AOC where corrective action has been completed without controls.

6.23 AOC-Q – Lab Drains

6.23.1 Unit Description

The HELSTF laboratory is located north of Building 26131 (Cleaning Facility). This laboratory supports various chemical analyses to support the HELSTF missions. In the 1988 RFA, A.T. Kearney reported that minor amounts of laboratory chemicals were discarded through laboratory drains. It was believed that the drains were connected to the Chemical Waste Tanks designated as SWMUs 31 and 32. Prior to the construction of the Chemical Waste Tanks, the drains were either connected to the sanitary treatment ponds or the effluent was collected and transferred to the ponds (A.T. Kearney, 1988).

6.23.2 Operational History

There is no additional information that pertains to the operational history associated with this AOC.

6.23.3 Regulatory History

The 1988 RF~~I~~A concluded that further action may be warranted to determine that actual waste management practices due to the uncertainty regarding the wastes that were discharged through the drains.

This AOC was omitted from the RCRA Permit. It was later moved to Table A.1 of the permit requiring corrective action by NMED as a result of the RFA conclusion. It has remained as a non-billable corrective action unit during the Annual Unit Audits (WTS, 2006). AOC Q is listed on the facility's current RCRA permit as an AOC with corrective action complete without controls. Therefore, the AOC is eligible for NFA and removal from the permit.

6.23.4 Investigative History

No investigations have been specifically been conducted for this AOC. The location and potential contaminants of this AOC preclude the possibility of distinguishing it from the underlying sites for SWMUs 142 and 154. Due to these conditions, no work was proposed related to this AOC individually. As proposed within the Phase III RFI Work Plan, any contamination resulting from a release at this AOC will be investigated as part of the RFIs conducted at SWMUs 142 and 154.

6.23.5 Nature and Extent of Contamination

As proposed within the Phase III RFI Work Plan, data collected during the Phase III RFI at the locations of SWMUs 142 and 154 are comprehensive enough to address any releases from the laboratory drains. The discussion for nature and extent for these SWMUs are addressed under Sections 6.12.5 (page 198) and 6.21.5 (page 326).

6.23.6 Human Health Risk Assessment Findings

As proposed under the 2006 Phase III RFI Work Plan, assessment of this location would be covered as part of the investigations for SWMUs 142 and 154. The results of HHRAs for these SWMUs are addressed under Sections 6.12.6 (page 210) and 6.21.6 (page 342).

6.23.7 Ecological Risk Assessment Findings

As proposed under the Phase III RFI Work Plan, assessment of this location would be covered as part of the investigations for SWMUs 142 and 154. The results of ERAs for these SWMUs are addressed under Sections 6.12.7 (page 213) and 6.21.7 (page 344).

6.23.8 Conclusions and Recommendations

The related releases are being addressed under the RFI process for SWMUs 142 and 154. No further assessment of conditions for this AOC is proposed. In addition, AOC Q is listed in the RCRA permit as an AOC where corrective action has been completed without controls. Therefore, the unit is eligible for NFA and removal from the permit.

6.24 AOC-V – Pressure Recovery System

6.24.1 Unit Description

~~As indicated in t~~The 1988 RFA described AOC V as a system that ~~, the pressure recovery system~~ removeds fluoride-containing compounds from gases generated by the deuterium fluoride chemical laser. As the ~~The~~ effluent gases from this process passed through a scrubber. ~~The device contains plastic saddles As the gases pass through the scrubber,~~ a countercurrent of dilute aqueous sodium hydroxide neutralizeds the hydrogen fluoride. The removal efficiency for the hydrogen fluoride ~~i~~was reported to be approximately 80 to 90%. The scrubber fluids weare then treated with calcium hydroxide to produce fluorspar (CaF_2). The fluorspar wais dried in the fluorspar tanks (SWMU Nos. 33-34). Reportedly, there weare no applicable air permits for this unit (A.T. Kearney, 1988). This unit was inactivated when chemical laser operations at the HELSTF ceased in 2009.

6.24.2 Operational History

There is no specific information pertaining to the operational history for this AOC. There are no known releases from this system.

6.24.3 Regulatory History

The RFA proposed no further action for this AOC. The AOC was subsequently omitted from the 1989 RCRA permit. The AOC ~~has~~ remained in Table A.2 of the Annual Unit

Audit, indicating that NFA ~~i~~was required (WTS, 2006). However, AOC V is listed in the current (2009) RCRA permit as a unit requiring corrective action.

6.24.4 Investigative History

There has been no investigation at this AOC. There are no borings or monitoring wells associated with this AOC (WTS, 2006).

6.24.5 Nature and Extent of Contamination

There has been no investigation at this AOC ~~. There are no borings or monitoring wells associated with this AOC~~ (WTS, 2006). The RFA proposed NFA for this AOC, and ~~.~~ ~~T~~the AOC was omitted from the 1989 RCRA permit. The AOC has remained in Table A.2 of the Annual Unit Audit, indicating that NFA is required (WTS, 2006). As stated previously, the unit is no longer operational. Based upon these conditions, an evaluation of the nature and extent of contamination for this AOC was not warranted.

6.24.6 Human Health Risk Assessment Findings

~~There has been no investigation at this AOC. There are no borings or monitoring wells associated with this AOC (WTS, 2006). The RFA proposed NFA for this AOC. The AOC was omitted from the RCRA permit. The AOC has remained in Table A.2 of the Annual Unit Audit, indicating that NFA is required (WTS, 2006). Based upon these conditions, a~~An HHRA for this AOC was not warranted since there have been no reported releases and no investigations conducted.

6.24.7 Ecological Risk Assessment Findings

~~There has been no investigation at this AOC. There are no borings or monitoring wells associated with this AOC (WTS, 2006). The RFA proposed NFA for this AOC. The AOC was omitted from the RCRA permit. The AOC has remained in Table A.2 of the Annual Unit Audit, indicating that NFA is required (WTS, 2006). Based upon these conditions, a~~An ERA for this AOC was not warranted since there have been no reported releases and no investigations conducted.

6.24.8 Conclusions and Recommendations

~~The RFA proposed NFA for this AOC and the AOC was omitted from the RCRA permit.~~There have been no historical releases reported from AOC V. Wastes

generated at this unit were placed in SWMUs 33 and 34. The unit has been out of operation since 2009. No RFI activities have been conducted at this AOC because the RFA proposed NFA and the unit was omitted from the 1989 permit. Based upon these conditions, NFA is proposed for AOC V (Pressure Recovery System).

6.25 Nature and Extent of COPCs in Groundwater

COPCs have been detected in vadose zone water and in the Regional Aquifer beneath the HELSTF area since investigation activities began in 1992. In many cases, contaminant releases that affected soil (described above) also resulted in impacts to shallow vadose zone water and, to a lesser extent, impacts to regional groundwater. Because the spatial distribution of vadose zone water is complex, the delineation of vadose zone water impacts can be difficult, particularly when contaminants released on one SWMU may have been transported beneath other SWMUs.~~Delineation is further complicated by the fact that groundwater in the vadose zone is heterogeneously distributed in three dimensions and conventional transport estimations that might otherwise be made in well-connected systems cannot be made here.~~

A better approach to the characterization of both vadose zone water and groundwater impacts at the HELSTF involves understanding the spatial distributions of different types of contaminants, then considering their distributions in the context of known uses and releases to build separate conceptual models for their sources, transport, and observed distribution. When this approach was taken for the HELSTF area, it became clear that there are three primary areas of affected vadose zone water where impacts by multiple constituents and significant transfers to the soil matrix, vadose zone water, and potentially regional groundwater have occurred. There have been detections, and sometimes exceedances of regulatory standards in other areas but, in general, they do not represent historical or persistent sources of contaminant mass that pose a risk to the Regional Aquifer going forward. Both types of impacts are described in the sections that follow.

6.25.1 Method of Analysis

To evaluate the nature and extent of these COPCs in vadose zone and regional aquifer water, individual maps were created for each COPC (Figures 6.25.5-3 through 6.25.7-10) that post all sample results observed between 2004 and 2009. In addition, Appendix H contains maps showing the locations of detections and regulatory exceedances of each class of COPC plotted on a site-wide basis and evaluated for emergent patterns in spatial distribution. Individual COPCs were then plotted

separately and evaluated to confirm that they could indeed be described by the same conceptual model as the group to which they had been assigned. These maps are followed by similar individual maps for each COPC.~~Rather than focusing on data from individual SWMUs and their surrounding area, as might be appropriate for delineating soil impacts, the analysis of groundwater contamination at the HELSTF was performed by:~~

~~***Identifying all of the COPCs that exceeded a relevant groundwater standard or screening level between 2004 and 2008; and grouping COPCs by contaminant class.*** Classes of COPCs were defined by grouping COPCs known to have common origins in waste releases.~~

~~***Plotting the general spatial distributions of COPCs by class on a site-wide basis in both the vadose zone water and regional groundwater; developing conceptual models for the release and distribution of classes of COPCs in vadose zone water and regional groundwater; and confirming that the distribution of each COPC in a given class could be explained by the conceptual model for its spatial distribution.*** Detections and exceedances of all COPCs in each class were plotted together on a site-wide basis to determine if spatial patterns indicative of real releases would emerge and could be fit to conceptual models for their release and resulting distribution. This technique was critical to overcoming the spatial heterogeneities that were evident in data sets comprised only of single COPCs or taken only from localized areas. In general, where COPC releases resulted in impacts to vadose zone water or regional groundwater, clear spatial models for the distribution of relevant COPCs were evident. To be certain that all exceedances were accounted for and thoroughly evaluated, detections and exceedances for each COPC were also plotted separately. Finally, the occurrence and distribution of LNAPL was evaluated separately as it was found to be well correlated with the spatial distributions of a number of COPCs and important to understanding their historical transport.~~

~~***Describing the COPC releases that resulted in impacts to vadose zone water and/or regional groundwater in terms of their origin, conceptual model for distribution, and potential for migration.*** The sections below describe how each class of COPCs and their constituents are distributed in the vadose zone water and regional groundwater at the HELSTF. The SWMU of origin for each release is identified and the delineation of each COPC's impacts is discussed in detail. In some cases, COPC concentrations are evaluated to provide insight on the relative significance of any impacts that could not be fully delineated.~~

6.25.2 Identification and Grouping of COPCs Exceeding Relevant Standards

Regulatory standards/screening values were used for delineation of both vadose zone water and groundwater in the Regional Aquifer. For vadose zone water, regulatory standards/screening values were used as a guide to confirm delineation and identify analytes~~COPCs~~ that may potentially be important with respect to impacts to the Regional Aquifer and should therefore be included on the COPC list. These standards/screening values were applied as described under Section 5.3.2 (Vadose Zone Water and Regional Aquifer Data Screening, page 74) and Tables 6~~.25-1~~22, ~~and~~ 6~~.25-2~~3, and Tables 1 and 2 of Appendix D-~~23~~ present historical and current data for all wells at the site.

However, for delineation purposes, the following detailed evaluation of groundwater conditions focuses on the time period between 2004 and ~~2008~~2009. This ~~4~~5-year time period ensures that there is a data set that includes sample results for the majority of the wells at the site and not just the subset of wells that are sampled on a semiannual basis. This approach ensures that the best possible data set is used to fully characterize vadose zone water and groundwater in the Regional Aquifer.

Once all analytes with ~~COPCs~~ exceedances~~ing~~ of relevant standards had been identified, they were grouped, as described above, for common spatial interpretations. All analytes with exceedances~~COPCs, with the exception of dibromochloromethane,~~ could be sorted into four classes: metals released as wastes, common anions, diesel fuel constituents (separated into low molecular weight [LMW] and PAHs for simplicity of analysis), and solvents. Dibromochloromethane was formerly used as a flame retardant and its common presence with the other COPCs detected cannot be explained. Dibromochloromethane can also be found in chlorinated drinking water as a disinfection byproduct, formed as a consequence of the reaction of chlorine with natural organic matter and bromide ions in the raw water supply (from lakes, reservoirs, rivers, etc).

COPCs exceeding relevant standards for vadose zone water, regional groundwater, or both are listed below, grouped by class as described above.

Summary of Exceedances in Vadose Zone and Regional Aquifer Water		
Analyte	**Vadose Zone Water**	**Regional Aquifer Water**
Explosives		
2-Nitrotoluene	X	--
2,4,6-Trinitrotoluene	X	--
Octahydro-1,3,5,7-Tetranitro-1,3,5,7-Tetrazocine (HMX)	X	--
Cyclotrimethylenetrinitramine (RDX)	X	--
Metals		
Aluminum	X	--
Antimony	X	X
Arsenic	X	X
Barium	X	--
Beryllium	X	X
Boron	X	--
Cadmium	X	--
Chromium	X	X
Cobalt	X	--
Copper	X	--
Hexavalent Chromium	X	X
Iron	X	X
Lithium	X	X
Manganese	X	--
Molybdenum	X	X
Nickel	X	--
Selenium	X	X
Strontium	X	X
Vanadium	--	X
Anions		
Fluoride	X	X
Chloride	X	
Nitrate		
Nitrite	X	
Sulfate	X	

Summary of Exceedances in Vadose Zone and Regional Aquifer Water		
Analyte	**Vadose Zone Water**	**Regional Aquifer Water**
Polynuclear Aromatic Hydrocarbons (PAHs) Diesel Fuel Constituents		
1-Methylnaphthalene	X	--
2-Methylnaphthalene	X	--
4-Aminobiphenyl	X	--
p-Chlorinoanaline	X	--
Acenaphthene	X	--
Chrysene	X	--
Bis(2-Ethylhexyl)Phthalate (Di[2-ethylhexyl] phthalate)	X	
Diphenylamine	X	
Fluorene	X	
Naphthalene	X	--
Nitrobenzene	X	
N-Nitrosodi-N-Propylamine	X	
Pentachlorophenol	X	
Phenanthrene	X	--
Pyrene	X	
Low Molecular Weight (LMW) Diesel Fuel Constituents		
Benzene	X	--
1,2,4-Trimethylbenzene	X	--
Phenol	X	--
Solvents		
1,1-Dichloroethane	X	--
1,1-Dichloroethylene	X	X
1,4-Dioxane	--	X
2,4-Dinitrotoluene	X	--
Methylene eChloride	X	--
Trichloroethene	X	X

Many of the analytes listed above were removed from further COPC evaluation and a condensed list was created (see below). An explanation as to why each respective analyte was removed from further COPC evaluation is provided below.

Explosives

- 2-Nitrotoluene, 2,4,6-Trinitrotoluene, Octahydro-1,3,5,7-Tetranitro-1,3,5,7-Tetrazocine (HMX) and Cyclotrimethylenetrinitramine (RDX) areis removed from COPC evaluation because ~~it~~they are ~~is~~ not in waste streams managed by the SWMUs.

Metals

- Antimony is currently not evaluated as a COPC because there is a low frequency of detection in the vadose zone water (1 well location) and the Regional Aquifer (2 well locations). Additionally, the reporting limits to-date have all been higher than the EPA MCL (6 µg/L); therefore, we propose to ~~continue sampling~~sample for antimony using a lower reporting limit for two additional sampling rounds. At that time, ~~but with a lower reporting limit~~ antimony will be evaluated to ~~accurately evaluate~~assess its presence in vadose zone and Regional Aquifer water.~~–~~

- Arsenic, cobalt, iron, manganese, and nickel are removed from COPC evaluation because they are naturally occurring redox-affected elements (Section 4.3.6.2).

- Aluminum, barium, boron, lithium, selenium, strontium, and vanadium are removed from COPC evaluation because they are elements from soluble minerals present at the site (Section 4.3.6.1).

PAHs

- Due to the low frequency of detections, 4-aminobiphenyl and p-chlorinoanaline are not considered for COPC evaluation as described below:

    - 4-aminobiphenyl was detected during one sampling event in four wells (DRW-02, DRW-03, DRW-04, and HCF-01) in the area of the SWMUs 142 and 154, conducted in April 2009. The compound was not detected in any previous or subsequent sampling events; and,

    - p-chlorinoanaline was detected during one sampling event in 1 well (HCF-05 in the area of SWMUs 142 and 154) conducted in April 2009. The compound was not detected in previous or subsequent events.

- Bis(2-Ethylhexyl)Phthalate was removed from further COPC evaluation because phthalates are common laboratory contaminants and are likely attributable to laboratory contamination.

- 2,4-Dinitrotoluene is removed from further COPC evaluation because there was only one detection (which also exceeded screening criteria) observed from 2004 through 2009. All samples results collected prior to the exceedance in April 2009 were below laboratory reporting limits. Additionally, one sample has been collected since the exceedance (September 2009) and the result came back below laboratory reporting limits.

- Diphenylamine was removed from further COPC evaluation due to low frequency of detection. It was detected during one sampling event in HCF-05, conducted in March 2004. The lone detection had a duplicate result of non-detect and the sample has been preceded by two additional samples with levels below laboratory reporting limits.

- Fluorene was removed from further COPC evaluation due to low frequency of detection. It was detected during two sampling events; one event at well HCF-05 in March 2004, and one event at well DRW-03 conducted in August 2004. The detection at well HCF-05 had a duplicate result of non-detect and has had three subsequent samples collected with all results below the screening level. The detection at well DRW-03 was a value of 5.17 µg/L, with a duplicate result of non-detect. Two subsequent samples have been collected and have resulted in levels below the screening level.

- Nitrobenzene has been removed from further COPC evaluation because it is not in waste streams managed by the SWMUs (see Section 6.1).

- N-Nitrosodi-N-Propylamine was removed from further COPC evaluation due to low frequency of detection. It was detected during one sampling event at well HMW-33 in August 2005. The detected value was accompanied by a duplicate result less than laboratory reporting limits. Additionally, seven subsequent samples have been collected in which all results were below laboratory reporting limits.

- Pentachlorophenol was removed from further COPC evaluation due to low frequency of detection. It was detected during one sampling event at well HMW-13 in February 2004. The detected value was accompanied by a duplicate result less

than laboratory reporting limits. Additionally, seven subsequent samples have been collected in which all results were below laboratory reporting limits.

- Pyrene was removed from further COPC evaluation due to low frequency of detection. It was detected during one sampling event at well HCF-05 in March 2004. The detected value was accompanied by a duplicate result less than laboratory reporting limits. Additionally, three subsequent samples have been collected in which all results were either below laboratory reporting limits or below the screening level.

Solvents

- Methylene chloride is removed from further COPC evaluation because it is a common laboratory contaminant (Section 5.3.3), which is supported by the observed occurrences in groundwater. Additionally, many of the results are flagged as also being detected in the method blank at the lab.

~~Dibromochloromethane was formerly used as a flame retardant and its common presence with the other COPCs detected cannot be explained. Dibromochloromethane can also be found in chlorinated drinking water as a disinfection byproduct, formed as a consequence of the reaction of chlorine with natural organic matter and bromide ions in the raw water supply (from lakes, reservoirs, rivers, etc).~~

The final list of analytes considered for COPC evaluation are listed below by class.~~analyte exceedances was condensed to only include the analytes that are being evaluated as COPCs and they are listed below exceeding relevant standards for vadose zone water, regional groundwater, or both are listed below, grouped by class as described above~~

~~Summary of Exceedances~~Final List of Analytes Considered for COPC Evaluation in Vadose Zone and Regional Aquifer Water		
Analyte	**Vadose Zone Water**	**Regional Aquifer Water**
Metals		
Beryllium	X	X
Cadmium	X	--
Chromium	X	X
Copper	X	--

~~Summary of Exceedances~~Final List of Analytes Considered for COPC Evaluation in Vadose Zone and Regional Aquifer Water		
Analyte	**Vadose Zone Water**	**Regional Aquifer Water**
Hexavalent Chromium	X	X
Molybdenum	X	X
Anions		
Fluoride	X	X
Polynuclear Aromatic Hydrocarbons (PAHs) Diesel Fuel Constituents		
1-Methylnaphthalene	X	--
2-Methylnaphthalene	X	--
~~Acenaphthene~~	~~X~~	~~--~~
Chrysene	X	--
~~Dibenzofuran~~	~~X~~	~~--~~
~~Fluorene~~	~~X~~	~~--~~
Naphthalene	X	--
Phenanthrene	X	--
~~Pyrene~~	~~X~~	~~--~~
Low Molecular Weight (LMW) Diesel Fuel Constituents		
Benzene	X	--
1,2,4-Trimethylbenzene	X	--
~~1,3,5-Trimethylbenzene~~	~~X~~	~~--~~
Phenol	X	--
Solvents		
1,1-Dichloroethane	X	--
1,1-Dichloroethene	~~--~~X	X
1,4-Dioxane	--	X
Trichloroethene	X	X

6.25.3 General Distribution of COPCs in Vadose Zone Water

~~Water in the vadose zone at the HELSTF is heterogeneously distributed and C~~clear connections between surface COPC releases and their distribution in vadose zone water at the HELSTF are difficult to make~~, probably~~ because many historical liquid releases were transient and very localized, draining over time toward the more persistent accumulations of water described here as vadose zone water. In general,

water was often encountered at shallower depths in areas where large water discharges or releases were known to have occurred. The depth to water has increased over time as those large-scale releases have been mitigated or ~~stopped~~ ceased and the system drains of stored water toward a steady state condition represented by the persistent leakage of supply water from the existing infrastructure.

The first encounter of vadose zone water occurs at approximately 20 ft bgs (3,933 ft amsl) in the area of the former Sanitary Treatment System (SWMU ~~s~~ 27~~, 28, 29, and 30~~). Across the remainder of the HELSTF site, vadose zone water is first encountered between approximately 25 and 45 ft bgs (3,929 and 3,909 ft amsl).

In the area of the HELSTF LSTC Wastewater Discharge ~~Point~~ Pond (SWMU 144), vadose zone water has historically been first encountered at approximately 23 ft bgs (3,930 ft amsl) (as represented by HMW-18, HMW-18B, HMW-25, and HMW-27); however; water levels have decreased with time and are now encountered at approximately 40 ft bgs (3,913 ft amsl), based on monitoring wells located in this area.

~~Monitor wells located in the vadose zone water at the HELSTF area are represented by monitor wells listed in Table 4-6 (Monitor Well Construction Summary).~~

Samples collected between 2004 and 200~~8~~9 in this ~~area~~ zone indicate exceedances of standards/screening values for the following COPCs: six metals (beryllium, cadmium, chromium, copper, hexavalent chromium, and molybdenum), one common anion (fluoride), ~~four~~ three LMW diesel constituents (benzene, 1,2,4-TMB, ~~1,3,5-TMB,~~ and phenol), ~~nine~~ five PAHs (1-methylnaphthalene, 2-methylnaphthalene, ~~acenaphthene,~~ chrysene, ~~dibenzofuran, fluorene,~~ naphthalene, and phenanthrene~~, and pyrene~~), and four solvents (1,1-DCA, 1,1-DCE, 1,4-dioxane, and trichloroethene).~~Although ethylene chloride results indicated exceedances of standards/screening criteria, it is a common laboratory contaminant (Section x-x), which is supported by the observed occurrences in groundwater and that many of the results are flagged as also being detected in the method blank at the lab. This analyte will not be discussed further as a COPC.~~

~~To evaluate the nature and extent of these contaminants COPCs in vadose zone water, individual maps were created for each COPC (Figure 6.25.5- through 6.25.-) that post all sample results observed between 2004 and 2009. In addition, Appendix H contains maps showing the locations of detections and regulatory exceedances of each class of COPC were plotted on a site-wide basis and evaluated for emergent patterns in spatial distribution. Individual COPCs were then plotted separately and evaluated to confirm that they could indeed be described by the same conceptual~~

~~model as the group to which they had been assigned. Maps for each class of COPC, describing where detections and exceedances occurred in vadose zone water, are provided in Appendix H; t~~These ~~maps~~ are ~~followed by similar individual maps for each COPC.~~The spatial analyses for each class of COPCs and their individual constituents is described in detail by class of COPC below. ~~but, in short,~~In summary, there appear to be three primary areas where constituent releases from the HELSTF SWMUs have resulted in affected vadose zone water:

1. In and around the area affected by SWMU 154 (HELSTF Systemic Diesel Spill). This area contains a number of individual SWMUs and is generally bounded by Vadose Zone Wells HCF-03, DRW-08, DRW-13, HMW-36, HMW-37, and HMW-38. The area is affected by multiple classes of COPCs, but all impacts seem to be related to either the SWMU 142 or SWMU 154 waste releases. **Hereinafter, this area will be referred to as the ~~SWMU 154/142~~SWMU 142/154 area.**

2. Near and to the north of SWMU ~~148~~ 143 (~~Former MAR Waste Pond~~Chromium~~ate~~ Spill Site). This area is contiguous with ~~SWMUs (~~SWMUs 141 and ~~143~~148~~)~~, and is generally bounded by Vadose Zone Wells DRW-10, HMW-11, HMW-39, HMW-40, HMW-41, and HMW-43, in addition to Regional Wells DRW-14 and HMW-42. **Hereinafter, this area will be referred to as the SWMU ~~148~~ 143 area.**

3. Near and to the north, east, and southeast of SWMU 144 (LSTC Wastewater Discharge). This area is generally bounded by Vadose Zone Wells HMW-31 and HMW-33, in addition to Regional Aquifer Wells HMW-32 and HELSTF-01. **Hereinafter, this area will be referred to as the SWMU 144 area.**

6.25.4 General Distribution of COPCs in Regional Groundwater

In the area of the HELSTF, the Regional Aquifer is encountered at an elevation between 3,887 and 3,882 ft amsl; depth to groundwater in the Regional Aquifer is approximately 70 to 75 ft bgs. The potentiometric surface in January 2009, Figure 4.3-~~6~~7, slopes to the southeast and the inferred groundwater flow is generally from the northwest towards the southeast, influenced heavily in this area by recharge from the nearest basin margin to the west and northwest. Potentiometric surface data was also collected in March and August of 2009 (Appendix C-1~~Table 4.3-6~~).~~; however, t~~ The January 2009 data ~~was~~were used in Figure 4.3-7 because the dataset was more complete and there were no notable changes in the potentiometric surface values between January and August 2009. Construction details for the ~~M~~monitoring wells located in the Regional Aquifer in the HELSTF area are presented in Table 5-2~~4-6~~.

Between 2004 and 200~~8~~9 i~~I~~n the Regional Aquifer, analytes showing exceedances of applicable WQCC ~~GWQCS~~ groundwater standards include VOCs (1,1-DCE, 1,4-dioxane, and TCE), one ~~other parameter~~common anion (fluoride), and four metals (beryllium, total chromium, hexavalent chromium, and molybdenum). Detailed discussion of the more recent exceedances is described below.

Of the constituents that exceed regulatory standards or screening levels in the Regional Aquifer, only total chromium and TCE have been detected with regularity and resulted in contiguous plumes. Other constituents that have exceeded regulatory standards have only done so sporadically and on a localized basis. These localized impacts to the Regional Aquifer are also discussed below.

~~As was done for the vadose zone water evaluation, the locations of detections and regulatory exceedances of each class of COPC were plotted on a site-wide basis as was done for vadose zone water, then evaluated for emergent patterns in spatial distribution.~~The spatial patterns of COPCs in the Regional Groundwater were analyzed using the same methods as the vadose zone water. Individual COPCs were also plotted separately and evaluated to confirm that they could indeed be described by the same conceptual model as the group to which they had been assigned. Maps for each class of COPC, describing where detections and exceedances occurred in regional groundwater, are provided in Appendix H; these are followed by similar individual maps for each COPC.

~~The spatial analyses for each class of COPCs and their individual constituents is described in detail by COPC class below, but in the Regional Aquifer T~~there appears to be only two areas where contaminant releases from the HELSTF SWMUs have resulted in Regional Aquifer ~~vadose zone~~ water impacts~~: and are defined below. The areas where the HELSTF releases appear to have affected the regional groundwater are as follows:~~

1. In and around the area of impacts to the vadose zone groundwater attributed to SWMUs 142 and 154. This area is generally bounded by Regional Wells DRW-15, DRW-16, DRW-17, and HMW-64. No impacts from the diesel fuel constituents present in the overlying vadose zone water are evident in this area, so it is reasonable to conclude that the flux of vadose zone water to the Regional Aquifer in this location is low; however, there is the potential for minimal contributions of chromium and TCE that cannot be distinguished from the higher concentration impacts attributed to the off-site source. It does seem that the affected area is

slightly wider in a northeast to southwest direction than it might be if the off-site source were the only contribution to concentrations in that area.

2. Near and to the southeast of the SWMU 144 area. This area is generally bounded by Regional Aquifer Wells HMW-32 to the northeast and HMW-59 to the southeast, and characterized near the source by HELSTF-01.

3. Sporadic exceedances of regulatory standards for a few COPCs have also occurred in and around ~~the~~ SWMUs 38 and ~~SWMU~~ 39 (Construction Landfill s) area~~s~~. Only individual exceedances of a few analytes occurred in this area, where Regional Aquifer conditions are characterized by one well, located downgradient (southeast) of SWMU 39 and one well located in the eastern portion of the SWMU 38 footprint, which is also downgradient of SWMU 39 and approximately 40 percent of the SWMU 38 area. The infrequency and irregularity of detections in this area suggests that there was no definitive source of COPCs to groundwater in this area.

4. Finally, there is evidence of an off-site source of relatively high concentrations of total chromium and TCE contamination that clearly extends from somewhere near or northwest of HMW-61 beneath the HELSTF in a narrow plume. ~~The~~ Historical concentration trends indicate that the plume ~~does~~ flowed~~pass~~ beneath an area of the HELSTF where minor contributions of the same constituents from the HELSTF sources are possible. The evidence that this contamination is indeed the result of an off-site source is discussed in Section 6.26 (page 385) and presented in detail in Appendix I~~H~~.

6.25.5 Evaluation of Individual COPC Distributions

As presented above, the classes of COPCs grouped for spatial interpretation included:

- LMW diesel fuel constituents;
- PAHs, representing mainly high molecular weight diesel fuel constituents;
- Solvents;
- Metals potentially released as wastes; and
- Common anions.

A separate discussion of the occurrence and distribution of residual LNAPL; in this case, separate phase weathered diesel fuel is also included, as it appears to have played an important role in the transport and distribution of a number of COPCs.

6.25.5.1 *LNAPL*

LNAPL occurs exclusively in the SWMU 142/154 area. The presence of LNAPL has been detected in vadose zone wells in this area ~~completed in the vadose zone water of this area~~ since 1990, when a boring was installed during the investigation at the Cleaning Facility. Based on product inventory analysis, it was estimated that somewhere between 100,000 to 175,000 gallons of product was lost at the site. The product skimming system and a vapor enhanced recovery system (VERS) recovered approximately 10,000 gallons of product during operation, and natural weathering processes of the LNAPL have also occurred. LNAPL thickness measurements since 1990 are summarized in Table 6.2~~45 1~~ 3 (Summary of LNAPL Measurements). LNAPL has been observed at 13 vadose zone wells in the area of the (HELSTF Systemic Diesel Spill Area (Figure 6.25.5-1). These wells include DRW-01 through DRW-03, HCF-01 through HCF 03, HCF-05, HCF-06/CFW-01, HCF-07, CFW-01, CFW-03, and PZ-2 through PZ-4. The extent of LNAPL present in the subsurface is well delineated and details of the data sets are discussed below.

The maximum thickness of product measured in monitor wells historically was 13.2 feet at HCF-07 in 1993. As of ~~December 2008~~August 2009, measured product thickness has decreased to ~~was measured at 7.3~~4.8 feet at this same well. ~~, which is still T~~the location with the greatest thickness of product currently observed is DRW-02 with 4.9 feet. In general, LNAPL measurements have decreased since 1990 (Figure 6.25.5-2) (LNAPL Trend Chart), with the one exception of HCF-03. LNAPL thickness at HCF-03 increased from 0.45 foot in 1993 to 2.16 feet in September 2006; however, it decreased again to ~~1.47~~1.14 feet between September 2006 and ~~December 2008~~March 2009.

Between 2006 and ~~2008~~2009, the LNAPL thickness in four wells (DRW-01 through DRW-03) increased by ~~0.91~~1.21, ~~1.61~~1.09, and ~~3.16~~1.09 feet, respectively. These wells were part of the product recovery system and LNAPL thickness increases at these wells appear related to rebound effects and are not indicative of LNAPL moving or increasing in this area. All other wells have shown stable or reduced thicknesses (Figure 6.25.5-2) (LNAPL Chart). Based on the trends observed and locations of these wells, the lateral extent of LNAPL appears to be shrinking.

Product samples were collected from Wells HCF-03 and HCF-07 in April 2009. The samples were submitted to the Southern Petroleum Laboratories, Inc., laboratory in Houston, Texas, for a suite of LNAPL analyses. These analyses included the determination of both physical and chemical parameters. The results of the chemical analyses demonstrate that the LNAPL samples are consistent with a weathered diesel fuel or No. 2 fuel oil. Weathering of fuels in the environment generally results in the preferential solubility and degradation of shorter hydrocarbons leaving longer, less soluble constituents in the subsurface. Therefore, with time, the dissolved phase COPC impacts associated with an LNAPL source become less significant. Trends in light, soluble hydrocarbons that support this ~~supposition~~ interpretation are discussed below.

The areal extent of the diesel fuel impacts in the subsurface currently includes areas beneath SWMUs 23 and 24 (Hazardous Waste Tanks at HELSTF), 25 (Waste Accumulation Area), 26 (Vapor Recovery Unit at HELSTF), 142 (HELSTF Cleaning Facility Sump), and 147 (Decontamination Pad and Underground Holding Tank). Both decreases in LNAPL thickness and the soil PAH ~~detection of diesel range constituents, particularly the higher molecular weight and biologically recalcitrant PAH class of compounds; however,~~data suggest that the historical areal extent of the ~~area affected by the~~ diesel fuel release was much larger in the past than ~~as~~ is depicted in Figure 6.25.5-1. Extents were estimated from a combination of historical free product gauging data and PAH impacts in deep soil. PAH concentrations above screening levels in deep soil are indicative of historical contact with LNAPL, as PAHs are not generally soluble enough in water to result in soil exceedances when contaminated water contacts clean soil.

The diesel fuel release also appears to ~~have been the vehicle for~~be the cause of distribution of other classes of COPCs. As an example, it appears that solvents released from SWMU 142 became commingled with the free phase diesel fuel, ultimately being distributed in the same spatial pattern and to roughly the same areal extent as the diesel constituents. Secondary geochemical effects related to the reducing conditions associated with the LNAPL also appears responsible for the dissolution of several naturally occurring metals in the soil. ~~This explains the heterogeneity in the areal extents of deep soil impacts that do not seem to be spatially correlated to recent vadose zone water contamination in many of these COPCs. This is discussed further below as it relates to specific COPCs or classes of COPCs.The diesel fuel-related COPC occurrence and distribution is presented first as a basis for understanding the distribution of other COPCs.~~

6.25.5.2 *Diesel Fuel Constituents*

The diesel fuel constituents were separated into two classes for spatial analysis (based roughly upon molecular weight) to make the number of constituents considered together manageable and to understand the potential for differences in dissolved-phase transport outside the area of LNAPL impact. The two classes were identified as LMW diesel constituents and PAH diesel constituents; all of which are listed with their relevant regulatory screening standards listed below.

Diesel Fuel ~~Constituents~~ COPCs and Relevant Standards			
Low Molecular Weight		**Polynuclear Aromatic Hydrocarbons**	
Constituent	**Vadose Zone and Regional Aquifer Water (µg/L)**	**Constituent**	**Vadose Zone and Regional Aquifer Water (µg/L)**
1,2,4-Trimethylbenzene	NM Tapwater – ~~12.3~~15	1-Methylnaphthalene	USEPA Tapwater – 23
~~1,3,5-Trimethylbenzene~~	~~NM Tapwater – 12.3~~	2-Methylnaphthalene	USEPA Tapwater – 150,~~500~~
Phenol	NM GWQCS – 5	~~Acenaphthene~~	~~NM Tapwater – 365~~
Benzene	USEPA MCL – 5	Chrysene (1,2-Benzphenanthracene)	NM Tapwater – ~~29.1~~92.1
~~m,p-Xylene~~	~~NM Tapwater – 203~~	Naphthalene~~Phenanthrene~~	NM Tapwater – ~~1,100~~1.43
~~n-Propylbenzene~~	~~NM Tapwater – 60.8~~	Naphthalene~~Phenanthrene~~	NM Tapwater – ~~6.2~~1,100

MCL Maximum Contaminant Level.
NM New Mexico.
NM GWQCS New Mexico Groundwater Quality Control Standard.
µg/L Micrograms per liter.
USEPA U.S. Environmental Protection Agency.

6.25.5.3 *Evaluation of Diesel Fuel Constituent Sources*

The SWMUs that managed diesel fuel or other wastes containing the same constituents included the following SWMUs: 37 (Waste Oil Accumulation Area at Building 26121 at HELSTF), 141 (Equipment Storage Area), and 154 (HELSTF Systemic Diesel Spill). Based upon the spatial analysis of impacts, it is concluded that the SWMU 154 diesel fuel release was the primary source for diesel fuel constituents in vadose zone water and regional groundwater. There is no evidence of releases indicated for SWMUs 37 and 141. Supporting figures showing the extent of diesel fuel~~and~~ associated COPCs are presented in Figures 6.25.5-3 to 6.25.5-1~~1~~0, as well as in ~~Appendix H as Figures H-1 through H-612 and H-34 through H-42~~.

6.25.5.4 *Extent of Diesel Fuel Contamination in Vadose Zone Water*

A site-wide spatial analysis of each diesel constituent group ~~was made and as expected~~indicates all impacts exceeding screening levels ~~proved to be~~are confined to the SWMU 154 area and its historical extent of probable NAPL impacts, including a related pipeline leak in the vicinity of HCF-03. In general, the distribution of diesel fuel constituents is consistent with a persistent interface between free-phase diesel fuel and vadose zone water. Concentrations of most constituents are highest where residual LNAPL exists and decrease moving away from the LNAPL. Individual COPC detections were spatially heterogeneous, consistent with the complex vadose zone structure and the history of both native weathering processes and interim treatments by vapor extraction and LNAPL recovery that have occurred there.

The constituents from the LMW group that exceeded standards were benzene, 1,2,4-TMB, ~~1,3,5-TMB, dibenzofuran,~~ and phenol.

- **Benzene (Figure 6.25.5-3)** was detected at 1~~2~~3 wells~~times~~ in vadose zone water, with ~~nine~~ ten wells ~~of the detections~~ exceeding the USEPA MCL of 5 µg/L from 2004 through 2009 ~~(DRW-01 through DRW-05, HCF-02, HCF-03, HCF-05, and HCF-07)~~. The current (September ~~2008~~2009) maximum detection observed is at DRW-02, at ~~45.8~~36 µg/L ~~Benzene concentrations in all surrounding wells are either non-detect or are reported below 5 µg/In general, benzene concentration trends observed at each of the monitor wells located in this area have shown overall decreasing trends (Figure 6.25.5-3). The lateral extent of benzene in the vadose zone water has decreased with time, and now concentrations in many wells that once exceeded the USEPA MCL of 5 µg/L are now below the standard. This further confirms that there is significant natural attenuation of benzene and that concentrations will continue to decrease in the future.~~

- **1,2,4-TMB (Figure 6.25.5-4)** was detected at ~~nine~~ ten wells, with six wells exceeding the New Mexico Tapwater screening value of 12.3 µg/L from 2004 through ~~2008~~2009. ~~These wells include DRW-01 through DRW-03, HCF-03, HCF-05, and HCF-07.~~ All of these wells are located in the area of SWMU 154, and appear to be related to the diesel spill previously discussed. Most recently (September ~~2008~~2009), the maximum concentration was observed at Well ~~DRW-02~~HCF-07, at a concentration of ~~48.6~~116 µg/L. All detections of 1,2,4-TMB occur in wells where benzene was detected in vadose zone water.

- **1,3,5-TMB (Figure 6.25.5-5)** was detected at six wells, with three wells exceeding the New Mexico Tapwater screening value of 12.3 µg/L from 2004 through 2008. These wells include DRW-01, DRW-03, and HCF-07. The highest concentration during this timeframe was detected at HCF-07, at 27.6 µg/L, in March 2004; however, all sampling performed after the detected exceedances at these wells show results below the screening value. All detections of 1,3,5-TMB occur in wells where benzene has also been a COPC in the vadose zone water.

- **Phenol (Figure 6.25.5-65)** was only detected once between 2004 and 2009, with the this one detection exceeding the NM GWQCS of 5 µg/L from 2004 through 20082009. It was detected at HMW-41, at a concentration of 5.71 µg/L in February 2004. All sampling events conducted since that time have yielded non-detect results.

The constituents from the PAH group that exceeded standards were 1-methylnaphthalene, 2-methylnaphthalene, acenaphthene, chrysene, fluorene, naphthalene, and phenanthrene, and pyrene.

- **1-Methylnaphthalene (Figure 6.25.5-76)** was detected at 14 wells, with 12 wells, all exceeding the USEPA Tapwater screening value of 23 µg/L from 2004 through 20082009. These wells include CFW-01, CFW-04, DRW-01, DRW-02, DRW-03, HMW-36, HMW-38, HCF-01 through HCF-03, HCF-05, and HCF-07; aAll wells are within the area of SWMU 154, except for HMW-36 and HMW-38. Although Wells HMW-36 and HMW-38 are not located in the vicinity of SWMU 154, they are located within the historical extent of LNAPL (Figure 6.25.5-71). Most recently in September 20082009, the highest concentration was detected at DRW-0203, at a concentration of 698 505 µg/L. All detections of 1-methylnaphthalene occur at wells where benzene has also been a COPC in the vadose zone water, except for HMW-36 and HMW-38.1-Methylnaphthalene has only been detected once above the screening value at Well HMW-36; however, sampling conducted since February 2006 indicates that results are now below 5.3 µg/L (August and December 2006 and September 2007).

- **2-Methylnaphthalene (Figure 6.25.5-87)** was detected at 12 wells, with exceedances of the USEPA Tapwater screening value of 1,500 µg/L occurring at 2 seven wells since from 2004 through 2009. These wells include HCF-05 and HCF-07; All both wells are within the area of SWMU 154 and had measurable LNAPL in 20082009. Most recently in September 2009, Tthe highest concentration was detected at HCF-07 05 in August 2004 at 26,300503 µg/L;

however, this well has not been sampled since.At HCF-05, 2-methylnaphthalene was detected at 11,700 µg/L in March 2004, and the most recent sample collected in August 2004 was detected at a concentration of 250 µg/L, well below the screening value of 1,500 µg/L.

- **Acenaphthene (Figure 6.25.5-9)** was detected at seven wells, with only one well exceeding the New Mexico Tapwater screening value of 365 µg/L from 2004 through 2008. The exceedance was detected at Well HCF-05 in March 2004 with a value of 760 µg/L. Well HCF-05 has only been sampled once since March 2004; however, the result in August 2004 was 14.5 µg/L, well below the screening criteria. Well HCF-05 is within the area of SWMU 154.

- **Chrysene (Figure 6.25.5-98)** was detected once three timeat four wells from 2004 through 2009; however, only one detection at well HCF-07 at one well, HCF-07, where the concentration exceeded the New Mexico Tapwater screening criteria of (29.1 µg/L.) in August 2004 with a value of 115 µg/L However, sSamples collected in April and September 2009 indicate chrysene results less than 5 ug/L. There were no other detections or exceedances of chrysene from 2004 through 2008. All threefour detectionwell locations are Well HCF-07 is located within the boundaries of SWMU 154.

- **Dibenzofuran (Figure 6.25.5-11)** was detected at eight ten wells, of which four wells exceeded the New Mexico Tapwater screening value of 12.2 µg/L since 2004. These wells include DRW-02, DRW-04, HCF-03, and HCF-07. All of the exceedance locations are within the vicinity of SWMU 154 with the exception of HCF-03. However, Well HCF-03 is located approximately 110 feet southeast from a former UST fuel line which is likely responsible for the dibenzofuran impacts in the area. Most recently, the highest detection was observed at DRW-02 on September 2008 with a value of 28.5 µg/L.

- **Fluorene (Figure 6.25.5-12)** was detected seven times with only one no well (HCF-05) exceeding the New Mexico Tapwater screening value of 243 1,460 µg/L from 2004 through 20082009. Well HCF-05 is located within the boundaries of SWMU 154. The highest detection during this time period was 376 Fluorene was detected at HCF-05 as high as 1,400 µg/L in March 2004April 2009 at well DRW-03. However, the August 2004 sampling event yielded a concentration of 29.2 µg/L, indicating that this contaminant was attenuated no longer exceeds the screening value.

- **Naphthalene (Figure 6.25.5-~~10~~9)** was detected at 11 wells, all~~ten~~ of which exceeded the New Mexico Tapwater screening value of ~~6.2~~1.43 µg/L from 2004 through ~~2008~~2009. ~~These wells include CFW-01, CFW-04, DRW-01 through DRW-03, HCF-01 through HCF-03, and HCF-05 and HCF-07.~~ These wells are located in the area of SWMU 154, and can be associated with the diesel spill previously discussed. As of ~~September~~ April ~~2008~~2009, the highest concentration of naphthalene was observed at ~~DRW-02~~HCF-03 at a concentration of ~~272~~ 142 µg/L.~~CFW-01 had one exceedance in October 2007 at 7.76 µg/L and CFW-04 had one exceedance in March 2006 at 6.72 µg/L. All other results at these wells are reported as non-detect.~~

- **Phenanthrene (Figure 6.25.5-~~10~~10)** was detected at ~~eight~~ seven wells, with two wells (HCF-05 and HCF-07) exceeding the New Mexico Tapwater screening value of 1,100 µg/L ~~from~~ between 2004 ~~through~~ and ~~2008~~2009. The maximum detection was at HCF-05 at a concentration of 3,750 ug/L in August 2004.~~At HCF-05, phenanthrene was detected at 2,790 µg/L in March 2004, but subsequent sampling reported a concentration of only 47.1 µg/L in August 2004, which was well below the screening value. At HCF-07, phenanthrene was detected above the screening value in August 2004 at a concentration of 3,750 µg/L. **Pyrene (Figure 6.25.5-15)** was detected six eight times from 2004 through 2008~~2009, with only two wells~~no detections exceeding the New Mexico Tapwater screening value (1,100~~183 µg/L) over the same time period. Pyrene was most recently detected during the September 2009 sampling event. at HCF-05 and HCF-07 concentrations of 378 µg/L (March 2004) and 323 µg/L (August 2004); however, all other sampling events at both wells have resulted in non-detections for pyrene.~~

6.25.5.5 *Extent of Diesel Fuel Contamination in Regional Groundwater*

No diesel fuel constituents have ever been detected in the regional groundwater.

6.25.6 Solvent Constituents

~~The~~ Four compounds in the solvent class of constituents were detected at concentrations exceeding screening criteria ~~includes 15 four compounds~~. They are listed below with their relevant screening or criteria or groundwater standards.

Solvent ~~Constituents~~ COPCs and Relevant Standards	
Analyte	**Vadose Zone and Regional Aquifer Water (µg/L)**
1,1-Dichloroethane (1,1-DCA)	NM GWQCS – 25
1,1-Dichloroethene (1,1-DCE)	NM GWQCS – 5
1,4-Dioxane	USEPA Tapwater – 61
Trichloroethene (TCE)	USEPA MCL – 5

MCL Maximum Contaminant Level.
NM New Mexico.
NM ~~G~~WQCCS New Mexico ~~Groundwater~~ Water Quality Control Commission Standard.
µg/L Micrograms per liter.
USEPA U.S. Environmental Protection Agency.

6.25.6.1 *Evaluation of Solvent Constituent Sources*

Based on historical records for the site, s~~S~~olvents were used and/or stored at a number of SWMUs at the HELSTF, as follows~~ SWMUs~~: 23 and 24 (~~Old~~ Hazardous Waste Tanks at HELSTF), 26 (Vapor Recovery Unit at HELSTF), 27 ~~through 30~~ (Sanitary Treatment System), 31 and 32 (Chemical Waste Tanks), 37 (Waste Oil Accumulation Area at Building 26121 at HELSTF), 141 (Equipment Storage Area), 142 (HELSTF Cleaning Facility Sump), 144 (HELSTF LSTC Wastewater Discharge ~~Point~~Pond), 146 (HELSTF STP Dry Pond), 147 (Decontamination Pad and Underground Holding Tank), and 148 (Former MAR Waste Stabilization Pond). Spatial analysis of solvent distribution in environmental media suggests impacts to either vadose zone water, the Regional Aquifer, or both, occurred in or near the following locations: SWMU 142 (HELSTF Cleaning Facility Sump), SWMU 144 (LSTC Wastewater Discharge), and SWMU ~~148~~ 143 (~~MAR Waste Stabilization Pond~~Chromate~~ate~~ium Spill Site). Supporting figures showing the extent of solvent COPCs in the vadose zone water and Regional Aquifer are presented in Figures 6.25.6-1 through 6.25.6-~~4~~ 6 and in Appendix H (Figures H-~~7~~13 through H-20~~13~~).

This investigation also identified an off-site source of TCE contamination in the Regional Aquifer that does affect the area under the HELSTF. See Section 6.26 and Appendix I for further evaluation of the off-site source.~~Supporting figures showing the extent of solvent COPCs in the vadose zone water and Regional Aquifer are presented in 6-4 and in Appendix H as Figures H-7 through H-13 (Figures H-7 through H-13).~~

6.25.6.2 *Extent of Solvent Contamination in Vadose Zone Water*

Although a number of solvent constituents were detected at the HELSTF, only ~~two~~three that exceeded screening criteria in vadose zone water were retained as COPCs~~,~~: 1,1-DCA, 1,1-DCE, ~~,~~ and TCE. ~~1,1-DCA detections were associated with both the SWMU 154/142 area and the SWMU 148 area, but exceedances of screening criteria were limited to the SWMU 154/142 area. Detections of TCE occurred in the SWMU 154/142 area, the SWMU 148 area, and the SWMU 144 area, but exceedances of screening criteria occurred only in the SWMU 148 and SWMU 144 areas.~~ The extents of solvent contamination in vadose zone water are well delineated in all areas with the possible exception of the vadose zone area east of ~~the~~ SWMU 144~~ area~~.

The specific spatial distributions of TCE and 1,1-DCA were as follows:

- **1,1-DCA (Figure 6.25.6-1)** was detected at 25 vadose zone wells within the HELSTF ~~area~~ between 2004 and 2009 in both the SWMU 142/154 and SWMU 143 areas, but exceeded standards at only 9 wells in the SWMU 142/154 area. The highest concentration, 251 µg/L was detected in DRW-01 in September 2009. Concentrations in most wells appear to be stable or declining and the available data does not suggest the lateral migration of 1,1-DCA contamination over time. The Regional Aquifer has not been affected, suggesting that there has been no vertical migration of 1,1-DCA to the Regional Aquifer despite evidence that vadose zone water from the area of its release does interact with regional groundwater.

- **1,1-DCE (Figure 6.25.6-2)** was detected at 17 vadose zone wells~~locations~~ within the HELSTF ~~area~~ between 2004 and 2009; however, only five locations have observed exceedances of the New Mexico groundwater standard (5 µg/L) during the same time period. The exceedances are spread over the SWMU 142/154, SWMU 143, and the SWMU 144 areas.

- **TCE (Figure 6.25.6-3)** was detected at ~~13~~ 20 ~~locations~~vadose zone wells within the HELSTF ~~area~~ between 2004 and ~~2008~~2009, in the ~~SWMU 154/142~~SWMU 142/154 area, the SWMU ~~148~~ 143 area, the SWMU 144 area, and near SWMU 149. Exceedances occurred in nine locations and were limited to ~~but exceeded standards only in the~~ SWMU ~~148~~ 143 and 144 areas. ~~Exceedances occurred in only 8 locations, at DRW-12; HMW-11; HMW-13; HMW-38; HMW-39, and HMW-41 in the SWMU 148 area, and at HMW-31 and HMW-33 in the SWMU 144 area. The highest concentration in the SWMU 148 area was 208 µg/L, reported in HMW-41 in August 2006. Concentrations in that well have declined since that~~

~~measurement and c~~Concentrations throughout the SWMU 1~~38~~ area have generally declined or remained stable with some variability. The concentrations in the immediate vicinity ~~the release~~ SWMU 143 ranged, in the most current samples, from 30 to 140 µg/L, declining rapidly with distance from the SWMU.

In the SWMU 144 area, only ~~two~~ three wells exhibited exceedances of the 5 µg/L MCL for TCE and ~~neither~~ none have ever contained concentrations above 10 µg/L. The highest reported concentration ~~just above the MCL at~~ 9.06 µg/L, recorded in HMW-33 in July 2004. Concentrations in that well have since declined to very near the MCL at ~~5.49~~ 4.75 µg/L as of ~~April 2008~~August 2009. Continued attenuation at the same rate in this well, and comparable attenuation in HMW-31 and HMW-07 will likely ~~have~~ result in concentrations ~~in both~~ below the MCL in all three wells within a few years. There is no evidence of the ongoing lateral migration of TCE from either area, and ongoing contributions to Regional Aquifer TCE contaminations from vadose zone sources appear to be minor ~~at best~~, as discussed in the next section. ~~**1,1-DCA (Figure 6.25.6-2)** was detected at 18 locations within the HELSTF area between 2004 and 2008; in both the SWMU 142/154 and SWMU 148 areas, but exceeded standards only in the SWMU 154/142 area. Exceedances occurred in DRW-01 through DRW-06 and in HCF-02 and HCF-07, and the most recent samples continued to show exceedances for 1,1-DCA in all but one of those locations (DRW-05). The highest concentration, 125 µg/L was detected in DRW-04 in August 2004 and concentrations have since shown a high degree of variability there but have generally declined with the most recent sample containing 86 µg/L in October 2007. Concentrations in most wells appear to be stable or declining and the available data does not suggest the lateral migration of 1,1-DCA contamination over time. The Regional Aquifer has not been affected, suggesting that there has been no vertical migration of 1,1-DCA to the Regional Aquifer despite evidence that vadose zone water from the area of its release does interact with regional groundwater.~~

6.25.6.3 *Extent of Solvent Contamination in Regional Groundwater*

TCE , 1,1-DCE, and 1,4-dioxane were the only solvent constituents detected in the Regional Aquifer at the HELSTF. As will be described in more detail below, the 1,1-DCE impacts to the Regional Aquifer appear to share a common off-site source with at least some of the TCE and high concentration chromium impacts, while the 1,4-dioxane impact represents only a single, unrelated detection. The evidence for a significant off-site source of TCE, 1,1-DCE, and chromium contamination, and an interpretation of the extents of the resulting plume is presented in Appendix I. In

summary, ~~, but in short~~ the location of the source is~~can be~~ inferred to be near or upgradient of HMW-61. ~~; and t~~The resulting plume is poorly delineated upgradient of the HELSTF, but well delineated within and downgradient of the HELSTF, where its areal extents have been well defined. ~~Any~~ TCE impacts to the Regional Aquifer from the SWMU ~~148~~ 143 area cannot likely be distinguished from those originating at the off-site source. However, ~~but~~ they do appear well delineated and clearly constrained to a small area around the SWMU ~~148~~ 143 area.

- ~~**TCE (Figure 6.25.6-34)** was detected at ten locations in the Regional Aquifer, exceeding screening criteria at nine of them: DRWs 14 through 17; HMW-54; HMW-55; HMW-61; HMW-64 in the main HELSTF area; and HELSTF-01 near the SWMU 144 area. The highest concentrations were reported at DRW-14 (171 µg/L in August 2008), DRW-16 (119 µg/L in January 2007), and at HMW-61 (116 µg/L in September 2008). Although the detection at DRW-14 is in reasonably close proximity to the most significant TCE concentrations detected in the vadose zone water (208 µg/L in HMW-41), the other two detections, both in the same concentration range, occurred well upgradient of any identified HELSTF source. Insight into potential relationships between the highest concentration detections of TCE in the Regional Aquifer can be drawn from the other COPCs detected. All of the high concentration Regional Aquifer TCE detections (>100 µg/L) were also accompanied by 1,1-DCE detections in the 10 µg/L range and total chromium concentrations exceeding 500 µg/L. Because 1,1-DCE was not detected in the vadose zone water near any of these locations, including HMW-41, and chromium was never detected at comparable concentrations in the vadose zone a separate and common source for the impacts observed at DRW-14, DRW-16, and HMW-61 is strongly implicated. The same source may also explain many of the lower concentration TCE detections in the main HELSTF area as they are all spatially contiguous, though contributions from the SWMU 148 area are also possible. The single location of detection at HELSTF-01, near the SWMU 144 area is not likely related to this separate source. Although its concentration is too low (35.1 µg/L in December 2006) to expect a detectable 1,1-DCE concentration, it does not exhibit the correlated chromium concentration that would be expected if it were related to that separate source.~~

- **1,1-DCE (Figure 6.25.6-4)** has ~~only~~ been detected at ~~four~~ six ~~locations~~regional wells at the HELSTF and only exceeded screening criteria at three ~~of them~~locations from 2004 through 2009~~: HMW-61, DRW-14, and DRW-16~~. ~~The highest concentration detection was 11.8 µg/L at DRW-14 in September 2007. Subsequent samples from that location have returned similar concentrations.~~ The

three locations ~~of~~ that showed exceedances are separated ~~spatially~~ by large distances. ~~and n~~None coincide with a known or suspected point of release from a HELSTF SWMU, but all three coincide with the relatively high TCE concentrations that ~~have been~~are attributed to an upgradient off-site source. ~~and i~~It appears that both 1,1-DCE and TCE share the same unidentified source.

- **1,4-Dioxane (Figure 6.25.6-5)** was only detected at one location in December 2006. ~~A concentration of 101 µg/L was reported at HMW-32 east of the SWMU 144 area.~~ During the same event, all surrounding wells were non-detect suggesting that the 1,4-dioxane detection was ~~either spurious~~anomalous and should not be considered a COPC. ~~or that 1,4-dioxane impacts to the Regional Aquifer there are localized.~~ No sources of 1,4-dioxane or other detections in soil or vadose zone water have ever occurred at the HELSTF.

- **TCE (Figure 6.25.6-6)** was detected at ten locations in the Regional Aquifer, exceeding screening criteria at nine locations from 2004 through 2009. As of March 2009, the highest concentrations were reported at DRW-14 and at HELSTF-01. Although the detection at DRW-14 is in reasonably close proximity to the most significant TCE concentrations detected in the vadose zone water (118 µg/L in HMW-41), the other two detections in the same concentration range (HMW-61 and DRW-16), occur well upgradient of any identified HELSTF source. Insight into potential relationships between the highest concentration detections of TCE in the Regional Aquifer can be drawn from the other COPCs detected at these same locations. The m~~M~~ajority of the high concentration ~~Regional Aquifer~~ TCE detections (>100 µg/L) in the Regional Aquifer were also accompanied by 1,1-DCE detections in the 10 µg/L range and total chromium concentrations exceeding 500 µg/L. Because 1,1-DCE was not detected in the vadose zone water near any of these locations, including HMW-41, and chromium was never detected at comparable concentrations in the vadose zone, a separate and common off-site source for the impacts observed at DRW-14, DRW-16, and HMW-61 is strongly implicated. The same off-site source may also explain many of the lower concentration TCE detections in the main HELSTF area, as they are all spatially contiguous, though contributions from the SWMU 143 area are also possible. The single location of the exceedance at HELSTF-01, near the SWMU 144 area is not likely related to this separate source. Although there is not a detectable 1,1-DCE concentration, it does not exhibit the correlated chromium concentration that would be expected if it were related to that separate source.

6.25.7 Metals Potentially Released As Wastes

~~Five~~ Six metals exceeded ~~for which there were either known anthropogenic uses or little data to support natural occurrence without spatial analysis exceeded~~ screening levels, as listed below. These metals, which were either known to have anthropogenic uses or showed little data to support natural occurrence, were evaluated as if they were released as wastes. ~~Chromium is regulated as both total chromium and in the hexavalent form. H, but however, at during different sampling times at the site,~~ cChromium was measured as either total chromium, dissolved chromium, or hexavalent chromium in separate analyses at different times. The hexavalent chromium results were ~~treated~~ evaluated separately~~independently~~. ~~but because~~ tThere were unexplainable discrepancies between total and dissolved chromium results.~~,~~ Ttherefore, a conservative approach was adopted in which the higher or the two values, when both were reported together, was compared to the total chromium standard. The data discussed as "total chromium" in the sections that follow may, therefore, sometimes be describing dissolved chromium results if, in the same samples, their reported concentrations proved to be higher than the total chromium concentrations.

Metal~~s Evaluated as Potential Waste Releases~~COPCs, and Relevant Standards	
Analyte	**~~Vadose Zone and Regional Aquifer~~ Water Standard (µg/L)**
Beryllium	~~NMED Tapwater 2 –~~ EPA MCL 4
Cadmium	~~NMED Tapwater 2 –~~ EPA MCL 5
Total Chromium	No Standard~~NMED Tapwater 2 – 110~~
Copper	NMED~~NMED Tapwater 2 – 1,000~~ GW
Hexavalent Chromium	NMED Tapwater 110~~NMED Tapwater 2 – 110~~
Molybdenum	NMED Tapwater ~~2 – 1~~83

NMED New Mexico Environmental Department.
µg/L Micrograms per liter.
EPA Environmental Protection Standard
MCL Maximum Containment Level
GW Groundwater

6.25.7.1 *Evaluation of Metals Sources*

Wastes that contained metals were managed at the following SWMUs: 25 (Waste Accumulation Area), 27 ~~through 30~~ (Sanitary Treatment System), 37 (Waste Oil Accumulation Area at Building 26121 at HELSTF), 38 and 39 (~~Construction~~ HELSTF Landfills), 141 (Equipment Storage Area), 143 (~~Chromate~~HELSTF Storage Yard Chromium Spill Site), 144 (HELSTF LSTC Wastewater Discharge ~~Point~~Pond), 146 (HELSTF STP Dry Pond), 148 (Former MAR Waste Stabilization Pond), and 154 (HELSTF Systemic Diesel Spill). Based upon the evaluation of the spatial distribution of metals and ~~from~~ the nature and extent evaluation described for each SWMU, impacts to vadose zone, regional groundwater, and/or both occur in the following areas: SWMU 143, SWMU 144, ~~SWMU 148,~~ and ~~SWMU 154/142~~SWMU 142/154. There are no evidences of releases of metals to vadose zone and regional groundwater for SWMU ~~s~~ 27~~ through 30~~, SWMU 25, SWMU 37, SWMUs 38 and 39, SWMU 141, and SWMU 146. Supporting figures showing the extent of metals in the vadose zone and Regional Aquifer are presented in Appendix H as Figures H-~~14~~21 through H-~~25~~32.

6.25.7.2 *Extent of Metal Contamination in Vadose Zone Water*

The constituents from the metals group that exceeded standards were beryllium, cadmium, total chromium, copper, hexavalent chromium, and molybdenum. Because different conceptual models for the occurrence and distribution of these constituents apply, delineation is discussed on a constituent-by constituent basis.

- **Beryllium (Be) (Figure 6.25.7-1)** was detected (as either total or dissolved) at ~~18~~ 22 ~~locations~~vadose zone wells from 2004 through ~~2008~~2009, with 19~~all~~ locations exceeding the groundwater screening criteria of 4 µg/L during the same time period. The exceedances occur ~~locations are segregated into~~in three general ~~groupings~~areas: ~~. The first group of exceedances is located in the SWMU 154/142~~SWMU 142/154 area~~, and consists of the following wells: DRW-01 through DRW-05, DRW-12, DRW-13, HCF-05, and HMW-13. t~~The second group of exceedances is located in the SWMU ~~148~~ 143 area~~, and consists of the following wells: HMW-11, HMW-36 through HMW-41, and HMW-43. t~~The third and final group of exceedances is located in the SWMU 144 area~~ and consists of Well HMW-33. Of all exceedance locations, the highest concentration observed from 2004 through 2008 were 12 µg/L, at HMW-39 in February 2004 and at HMW-33 in March 2005.~~ Of the 19 well locations where exceedances were observed, no location had an exceedance for the most recent sampling events conducted in 2009. Beryllium detections cannot be explained by known use or releases as wastes. Despite the absence of historical detections outside of the HELSTF, enriched concentrations of beryllium are commonly found in granitic pegmatites, a rock type that is likely present along the margins of the Tularosa Basin, and in clays, sandstones, limestones and residual materials up to 5.0 mg/kg (Wedepohl, 1966, Griffitts et al., 1977). ~~It is possible that low concentrations of naturally occurring beryllium were made soluble based on shifts in geochemistry related to the occurrence of diesel.Beryllium detections cannot be explained by known use or releases as wastes; it is possible that low concentrations of naturally occurring beryllium were made soluble based on shifts in geochemistry related to the occurrence of diesel. No samples have been collected from any of the exceedance locations since February 2006.~~

- **Cadmium (Cd) (Figure 6.25.7-2)** was detected (as either total or dissolved) at ~~22~~ 21 ~~locations~~vadose zone wells from 2004 through ~~2008~~2009, 8 of which exceeded the groundwater screening criteria (5 µg/L) during the same time period. The cadmium exceedances ~~locations are distinguished by two groups~~occur in two general areas: ~~. The first group of exceedances is in~~ the ~~SWMU 154/142~~SWMU

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142/154 area and ~~consists of Wells HCF-05 and HMW-13. t~~The second group of ~~exceedances is in~~ the SWMU ~~148~~ 143 area ~~and consists of Wells HMW-11, HMW-36 through HMW-39, and HMW-43~~. However, none of the wells with historical exceedances showed cadmium concentrations above laboratory reporting limits during 2009 sampling. ~~Samples have not been collected from~~All of ~~the exceedance locations since 2006~~were sampled in 2009 and were below laboratory reporting ~~limits in all wells. Prior to that, the maximum concentration observed at the exceedance locations was 53 µg/L, at HMW-39 in August 2006. Like beryllium, cadmium detections cannot be explained by known use or releases as wastes; and, like beryllium, it is possible that low concentrations of naturally occurring cadmium were made soluble in the same way~~.

- **Chromium (Cr) (Figure 6.25.7-3)** was detected (as either total or dissolved chromium) in vadose zone water at numerous locations in nearly all areas of the HELSTF facility from 2004 to 2009~~. The with the~~ exception ~~of~~ is in the southeast corner of the facility~~. from 2004 through 2009~~. Chromium concentrations (~~when taken as~~ total and/or dissolved ~~chromium~~) exceeded standards at ~~17~~ 20 locations spread over the following SWMU areas: ~~the~~ ~~: DRW-01, DRW-02, DRW-06, DRW-08, DRW-12, and DRW-13; CFW-01, HMW-08, and HMW-13 in the SWMU 154/142~~SWMU 142/154; ~~area, the ; HMW-11, HMW-39, and HMW-41, and DRW-10 in the~~ SWMU ~~148~~ 143; ~~area, the ; HMW-07, HMW-31, and HMW-33 in the~~ SWMU 144; ~~area~~ and in just one location, ~~HMW-12~~ near SWMUs 151 and 152. The highest concentration ~~detection~~ detected was ~~1,570~~ 6,900 µg/L at DRW-~~12,~~10, in the ~~SWMU 154/142~~SWMU 143 area in ~~August 2005~~March 2009. The chromium concentration in vadose zone water from Well HMW-12 ~~Concentrations, but concentrations had decreased by fivefold by September 2007, when it was last sampled. The next highest concentration detection was at HMW-33 in the SWMU 144 area at 1,540 µg/L in February 2004. Concentrations had also decreased there, to 591 µg/L, by August 2008, when it was last sampled.~~ Concentrations ~~in both the SWMU 144 area and~~ near SWMUs 151 and 152 exceeded the NMED groundwater standard in 2006, but were below the NMED groundwater standard in 2009.~~generally lower and recent trends suggest decreasing concentrations with tim~~

- **Copper (Cu) (Figure 6.25.7-4)** was detected (as either total or dissolved) at 27 ~~locations~~ wells ~~from~~ between 2004 ~~through~~ and ~~2008~~2009. However, ~~of the many detection locations,~~ only ~~2~~ two wells in the SWMU 143 area, HMW-36 (in 2006) and HMW-38 (in 2005), exceeded the groundwater screening criteria for Cu (1,000 µg/L). ~~The exceedances were observed at Wells HMW-36 and HMW-38,~~

which are located in the SWMU 148 143 area. Currently, Cu concentrations at both wells are have been below screening criteria. since the exceedances were detected in 2005 and 2006. There are no exceedances of Cu in vadose zone water at the HELSTF.Well HMW-36 exceeded the screening criteria in February 2006 with a concentration of 1,340 µg/L; the well has not been sampled since August 2006 where the concentration was drastically reduced to 6 µg/L. Well HMW-38 exceeded the screening criteria in August 2005 with a concentration of 2,000 µg/L. HMW-38 was last sampled in February 2006, where concentrations fell well below the screening criteria, to a concentration of 208 µg/L. Cu exceedances have been fully delineated across the HELSTF area.

- **Hexavalent Chromium (Cr [VI]) (Figure 6.25.7-5)** was detected at 12 numerous locationswells, with ten exceedances of groundwater screening criteria (110 µg/L) observed . Bbetween 2004 and 2009, screening criteriea were exceeded at observed at 7 of the locations from 2004 through 2008. The exceedance locations can be divided into three groupsin three SWMU areas: . Two exceedances occurred in the SWMU 154/142SWMU 142/154 area, the SWMU 143 area, and wells near the SWMU 144 area. HCF-05 had a reported concentration of 97 µg/L in March 2004, but was measured at only 57 µg/L (below the screening level of 110 µg/L) in August 2004. DRW-13 was measured at 570 µg/L in August 2005 and has not been sampled since. The second group of exceedances consists of four wells (HMW-11, HMW-36, HMW-39, and HMW-41) located near the SWMU 148 area but more likely attributable to the SWMU 143 chromate release. The maximum concentration observed in this area was 1,610 µg/L, at HMW-41 in February 2004. Well HMW-41 was last sampled in August 2005 with a concentration of 1,260 µg/L. A single exceedance at HMW-3 is located in the SWMU 144 area. The maximum concentration observed at HMW-33 from 2004 through 2008 was 1,470 µg/L, in February 2004. HMW-33 was last sampled in August 2005 with a concentration of 1,130 µg/L. Vadose zone hexavalent chromium impacts are not well delineated as hexavalent chromium to the east and southeast of their most significant detections in all three areas SWMU 144 areas;, however, in the areas to the east and southeast of the SWMU 154/142SWMU 142/154 area and the SWMU 143 (ChromiumateSpill Site) areas, total chromium measurements, which include hexavalent chromium, are do delineated at an even lower screening level (50 µg/L rather than 110 µg/L).

- **Molybdenum (Mo) (Figure 6.25.7-6)** was had numerous detectedions (as either total or dissolved) at 28 locations from 2004 through 20082009, resulting in 21 exceedances of groundwater screening criteria (183 µg/L). The exceedance

locations are ~~categorized into four groups~~grouped in four SWMU areas: ~~the first group of exceedances is located in the SWMU 154/142~~SWMU 142/154 ~~area,~~ ~~and consists of ten wells (DRW-02 through DRW-04, DRW-06, DRW-08, DRW-12, DRW-13, CFW-04, HCF-01, and HMW-13). The maximum concentration observed in the first group of exceedances was 657 µg/L, in March 2004 at Well DRW-03. The most recent sample collected at DRW-03 showed Mo concentrations had decreased to 374 µg/L. The second group of exceedances is in~~ the SWMU ~~148~~ 143 ~~area,~~ wells ~~and consists of eight wells (HMW-11, HMW-36 through HMW-41, and HMW-43). The maximum concentration observed in the second group was 1,380 µg/L, in July 2004 at Well HMW-40. The most recent sample collected in August 2006 showed Mo concentrations decreased to 887 µg/L at HMW-40. The third group consists of two wells (HMW-01 and HMW-04)~~ located near SWMU ~~s~~ 27 ~~through 30~~ (Sanitary Treatment System), and ~~. The maximum concentration observed at HMW-01 was 798 µg/L, in October 2005; the well has not been sampled since. The maximum concentration observed at HMW-04 was 638 µg/L, in October 2005, and this well has also not been sampled since. The fourth and final group of exceedances is located in the~~ SWMU 144~~area and consists of one well, HMW-33.The maximum concentration observed was 1,280 µg/L, in February 2004; the most recent sample collected in August 2006 yielded an Mo result of 914 µg/L.~~

6.25.7.3 *Extent of Metal Contamination in Regional Groundwater*

The constituents from metals group that exceeded standards in the regional groundwater were beryllium, chromium, hexavalent chromium, and molybdenum.

- **Beryllium (Be) (Figure 6.25.7-7)** was detected (as either total or dissolved) at five locations ~~all of which exceeded~~above the groundwater screening criteria (4 µg/L) from 2004 through ~~2008~~2009. The exceedance~~s locations are divided into two groups~~occur in two SWMU areas: ~~the . The first group consists of Well DRW-16, which is located just north of SWMU 154~~SWMU 142/154 ~~area~~ and ~~the area~~ surrounding SWMU 144. The regional wells in the SWMU 144 Area had one-time beryllium exceedances in 2005 and have not had any exceedances since then. Only one regional well (DRW-16) had beryllium exceedances in groundwater, once in 2004 and once in March 2009. During all other sampling events at DRW-16 (including during September 2009), beryllium has not been detected. ~~All of the wells with historical exceedances were sampled in August/September 2009 none showed concentrations above laboratory reporting limits.~~

- **Chromium (Cr) (Figure 6.25.7-8)** was detected (as ~~either~~ total or dissolved chromium) in regional groundwater water at ~~17~~ 19 locations. ~~(m~~Most locations where it was analyzed for showed low-level concentrations, ~~)~~ suggesting that it may represent a background condition at low concentrations. Total chromium c~~C~~oncentrations ~~(when taken as total chromium)~~ exceeded the groundwater screening criterion~~a~~ (50 µg/L) ~~standards~~ at ~~six~~ nine locations. Three locations (HMW-61, DRW-16, and DRW-14) are clearly attributable to the off-site source described in the Solvents section above and in Appendix I. ~~They~~ These wells exhibit similar concentrations and proportions of chromium, TCE, and 1,1-DCE, which are not found in samples attributable to other sources. ~~The highest concentration detection in this group was 7,720 µg/L, at DRW-16 in August 2005; concentrations remained in that range as of August 2008.~~ Three separate locations (DRW-15, DRW-17, and HMW-55), all in the ~~SWMU 154/142~~SWMU 142/154 area appear to be unaffected by the off-site source but exhibit exceedances in the ~~51~~ 40 to ~~131~~ 184 µg/L. ~~These concentrations are likely indicative of either the dissolution of naturally occurring chromium under the lower redox conditions that exist there as a result of the diesel fuel release or anthropogenic sources from site processes.~~ Three other locations (HMW-16, HWM-62, and HELSTF-01) are spread among SWMUs 143 and 144.

- **Hexavalent Chromium (Cr [VI]) (Figure 6.25.7-9)** was ~~only analyzed for~~detected ~~in six~~ at 14 locations ~~(DRW-16, DRW-17, HMW-29, HMW-32, HMW-34, and HMW-35)~~ and ~~detected~~ exceeded groundwater screening criteria (110 µg/L) at ~~three~~ five locations ~~(DRW-16, DRW-29, and HMW-34)~~ from 2004 through ~~20082~~2009. ~~Only one location (DRW-16) exceeded groundwater screening criteria (110 µg/L) for the same time period with a maximum reported concentration of 528 µg/L, in August of 2005.~~ The data collected for hexavalent chromium is insufficient to delineate impacts directly. ~~but b~~Because hexavalent chromium is measured as a part of the total chromium measurement and the total chromium screening level (50 µg/L) is lower that the hexavalent chromium screening level (110 µg/L), it can be concluded that the total chromium characterization does in fact delineate hexavalent chromium in the Regional Aquifer on and downgradient of the HELSTF. It is believed that the chromium attributed to the unidentified off-site source does include a high proportion of hexavalent chromium so the delineation of hexavalent chromium contamination upgradient of the HELSTF toward and around that source must be considered incomplete. Although SWMU 143 represents a known release of chromate-containing waste, there is no evidence that the release has impacted regional groundwater in that area.

- **Molybdenum (Mo) (Figure 6.25.7-10)** was detected (as either total or dissolved) at six locations from 2004 through 20082009, with three locations (HMW-32, HMW-34, and HMW-35) exceeding the groundwater screening criteria (183 µg/L) during the same time period. All of the exceedance locations are located near SWMU 144 in the northeast corner of the HELSTF. The maximum concentration observed was 315 µg/L, detected at HMW-35 in February 2004. The most recent sample collected at HMW-35 in August 2006 showed concentrations had declined to 275 µg/L. With the exception of the Mo exceedances detected in regional groundwater from HMW-35 in this area, no exceedances of Mo have been detected in regional groundwater from HMW-32 and HMW-34 since 2005 and 2004, respectively. Subsequent sampling events at these wells have not detected molybdenum.

6.25.8 Common Anions

The only common anion that may have had the potential to have been released as a waste is fluoride. Fluoride is ubiquitous in the gypsiferous soil matrix at the site, but was handled at the SWMU 33/34 area (Fluorspar Tanks) and a one-time discharge of wastewater containing fluoride occurred at SWMU 145 (Test Cell 4 Lagoon). Nearly all wells in both the vadose zone water and regional groundwater exhibit exceedances of the 1,600 µg/L NM GWQCCS and there is a high degree of variability in dissolved concentrations. Spatial analyses of fluoride detections in both the vadose zone water and regional groundwater, provided in Appendix H (depicted on corresponding figuresFfigures H-304 and H-3316) provided in Appendix H, indicated no pattern of spatial distribution suggestive of impacts correlated to site activities. Some high concentration detections in both the vadose zone (49,400 µg/L, at HMW-53 in late August 2008, and 12,500 µg/L, measured at DRW-02 in early September 2008) and regional groundwater (><15,000 µg/L in five wells sampled in late Aaugust and early September 2008) track back to a single sample collection event and suggest a single batch of samples that experienced a dilution reporting error or other data quality problem (Tables 6-25-2221 and 6-25-2322). A number of nearby wells, sampled only a few weeks earlier, indicated fluoride concentrations that were 'typical' of historical concentrations in both systems. Supporting figures showing the extent of anions in the vadose zone and Regional Aquifer are presented in Appendix H as Figures H-33326 through H-3336.

6.25.9 Conclusions for Vadose Zone Water and Regional Groundwater Evaluations

Based upon the data evaluation for vadose zone water and regional groundwater evaluations, the following conclusions are being made:

- Releases at some of the HELSTF SWMUs did affect ~~shallow soil, deep soil,~~ vadose zone water, and regional groundwater.

- A number of naturally occurring constituents exceed published standards in wetted site soils and initially failed COPC screening. Further analysis of the nature and origins of these constituents eliminated many of them from consideration as COPCs. The majority of the RFI analysis was done only in the context of the COPCs determined to be of anthropogenic origin and related to the HELSTF activities.

- Vadose zone water contamination is only of concern with respect to its potential to affect the Regional Aquifer as it is not suitable for development as a water resource itself.

- The potential for the transport of COPCs to the Regional Aquifer is limited by the net groundwater flux from the vadose zone downward to the Regional Aquifer surface~~. Available data suggests~~ that ~~this~~ is currently estimated to occur ~~ring in the 1- to 5-gallon-per-minute range~~ at 2.1 gpm and ~~that it~~ is likely dispersed over numerous points of contact. As a result, the net contribution of COPCs to the Regional Aquifer from the HELSTF SWMUs is believed to be too small to create COPC concentrations in the Regional Aquifer that exceed either published or risk-based standards.

- The COPCs that do exceed published standards in the Regional Aquifer, namely TCE, 1,1-DCE, and chromium, were primarily released upgradient of the HELSTF at an as-yet uncharacterized off-site separate source. While there do appear to be minor contributions of the same COPCs by vadose zone water affected by the HELSTF SWMUs, these are contributing at levels that would not cause exceedances of standards independent of commingling with the plume from the off-site source. The exception to this interpretation is the SWMU 144 area, where COPCs released affected both vadose zone water and regional groundwater at levels exceeding published standards. This area is not contiguous with, and can be characterized separately from both the main HELSTF area and the off-site source.~~problem~~

- In ~~short~~summary, the areas that exhibit groundwater impacts from HELSTF activities are the SWMU 142/154 area where there is some residual diesel NAPL and 1,1-DCA exceeding standards; the SWMU ~~148~~ 143 area (including the area downgradient of SWMU 143) where TCE and chromium concentrations exceed standards; and the SWMU 144 area where TCE and chromium concentrations exceed standards. None of these areas are believed to contribute, on an ongoing basis, to exceedances of standards in the Regional Aquifer.

6.26 Off-Site Source of TCE, 1,1,-DCE, and Chromium in the Regional Aquifer

The Phase III investigation produced data that shows a plume of groundwater contaminated with TCE, 1,1-DCE, and chromium, with an unknown source upgradient of the HELSTF, migrating under the HELSTF. Although this was not evident during field activities and discretely investigated, technical analysis of the available data using several lines of evidence supports this interpretation. As discussed in detail in Appendix I, the following results are key elements of this interpretation:

- Groundwater recovered ~~at~~from regional wells HMW-61, DRW-16, and DRW-14 exhibits a unique contaminant signature, containing TCE ~~over~~ near 100 µg/L, total chromium over 500 µg/L, and 1,1-DCE in the 10 µg/L range (Figures 6.26-1, 6.26-2, and 6.26-3, respectively). There are no other wells in either the vadose zone or Regional Aquifer that exhibit this combination of contaminant concentrations.

  - ~~In the~~ The 2009 data~~,~~ indicated that 1,1-DCE is almost uniquely detected in ~~these wells~~ regional wells HMW-61, DRW-16, and DRW-14. ~~As of 2009,~~ ~~o~~Only three wells ~~It has not~~ slightly exceed~~ed~~ the~~its~~ ~~10~~ 5 µg/L standard in the vadose zone since (Figure 6.25.6-2)~~2004~~ and there is no evident source on the HELSTF;

  - Chromium concentrations in DRW-16 and DRW-14 far exceed concentrations detected in vadose zone groundwater anywhere at the HELSTF, indicating that there is no realistic surface or near-surface source at the HELSTF. Even the known release of chromate waste at SWMU 143 has not resulted in the magnitude of concentrations observed in the Regional Aquifer at these wells. ~~For example, appears to have produced only a very small affected area in the vadose zone with nearby~~ vadose zone water concentrations at HMW-41 ~~that~~ are only 25 percent of those detected in the nearby Regional Aquifer well ~~at~~ DRW-14; and

- The only area where vadose zone water TCE concentrations have been as high as those detected in the Regional Aquifer ~~at these three locations~~ is at ~~lso in~~ HMW-41, where TCE concentrations are ~~approximately twice as high (around 200 µg/L)~~at 118 µg/L as of August 2009.

- Groundwater data at HMW-41 ~~therefore~~ represents the nearest match in COPC concentrations with the off-site source, ~~and must be considered to be the most likely to be related in source to the observed plume~~ but several factors discount the connection, namely that:

  - Differences in water quality do not support attributing them to the same source. In particular, HMW-41 ~~has~~ recently has shown twice the concentration of TCE, less than 25 percent of the chromium concentration and no detections of 1,1-DCE; and

  - The spatial distribution and magnitude of COPCs in the vadose zone water ~~in~~ near HMW-41 ~~seems to represent a~~indicate that impacts at HMW-41 are the result of a~~s~~ very localized release or a combination of releases from nearby SWMUs. Based on the complexity of the vadose zone stratigraphy, it is unlikely that ~~that could not have represented~~this localized source would have sufficient volume to affect the Regional Aquifer at such distances. Further, this area is near the downgradient end of the Regional Aquifer plume and there are a number of unaffected vadose zone wells between the area and the apparent upgradient source of the Regional Aquifer plume.

- Analysis of historic concentration trends in the three affected regional wells shows clear evidence of a breakthrough phenomenon, as shown in Appendix I, consistent with an upgradient release and subsequent migration through these locations. Even simple modeling solutions fit the data very well, lending a high degree of confidence to the conceptual model.

- ~~There is no credible scenario under which a release at a HELSTF SWMU could have supported the transport of this type or quantity of contaminated water to the HMW-61 location without the detection of similar water in the vadose zone near the SWMU that caused the release or between an existing SWMU and HMW-61. Other known releases of large volumes of liquids at the HELSTF, at the LSTC discharge point for example, did not result in the transport of contaminants to these distances in the same structural setting.~~

- There is no credible scenario that could explain a release at a HELSTF SWMU that could have resulted in the transport of the type or quantity of impacted water to the upgradient HMW-61 location without similarly-impacted water being detected in the vadose zone either near a SWMU that caused a release or from an area located between an existing SWMU and HMW-61. This is supported with the knowledge of other known releases of large volumes of liquids that occurred at the HELSTF (i.e. the LSTC discharge point) which did not result in the transport of contaminants to these distances in the same structural setting.

The conceptual model for contaminant release and transport is explored in greater detail in Appendix I.

6.27 HELSTF Regional Groundwater

An HHRA was conducted to evaluate potential risks associated with human exposure to COPCs in groundwater from the Regional Aquifer. A site-wide approach was used for the HHRA of the Regional Aquifer because the aquifer is continuous and exhibits similar exposure potential across the HELSTF site. In addition, as previously described in this report, the complexity of the hydrogeologic setting makes a SWMU-by-SWMU evaluation of groundwater impracticable at this site.

6.27.1 Risk Assessment Approach

The risk assessment approach was based on NMED guidance (NMED, ~~2006a~~2009a) and USEPA guidance for risk assessments (USEPA, ~~2008a,~~2009a~~b~~; 2007; 2004a,b; 2003; 2002a,b; 2000; 1997a,b; 1992a,b; 1991a,b,c; 1989), and is described in more detail in Section 5.4.2 (page 80). A detailed description of the HHRA is included in the complete HHRA report in Appendix E. A summary of the HHRA report is provided below.

In accordance with NMED guidance (NMED, ~~2006a~~2009a) for the screening of site data, constituent concentrations in regional groundwater were compared to health-based screening levels and the calculated ratios summed. The ratios were multiplied by $1x10^{-5}$ for carcinogens and by 1 for non-carcinogens. The total screening risk and total screening hazard index exceeded the NMED target screening risk and target hazard index for both the potable use and inhalation of vapors migrating to indoor air exposure scenarios. Therefore, a quantitative HHRA was performed.

~~The total ratios exceeded the NMED target ratio of 1 for both the potable use and inhalation of vapors migrating to indoor air exposure scenarios. Therefore, a quantitative HHRA was performed.~~

There are currently no points of exposure to groundwater at the WSMR installation, including the HELSTF sites, because all potable water for the installation is provided via a secure water supply system located approximately 7 miles from WSMR. Therefore, under current conditions, exposure to groundwater ~~at~~ via water supply well is not a complete exposure pathway.

The hypothetical future groundwater exposure pathways evaluated in the HHRA included use of groundwater as a potable water supply and inhalation of vapors migrating from groundwater into a building. Individuals using the groundwater could be exposed through ingestion, dermal contact, and inhalation of vapors. The inhalation pathway is complete under two scenarios. Vapors can occur in ambient indoor air from water used as a potable water supply (e.g., during residential showering). Vapors can also be present in indoor air through subsurface vapor intrusion into buildings. Potential future exposures of site workers and residents were evaluated for the regional groundwater. The ELCRs and non-cancer HIs for each potentially exposed receptor included in the risk assessment for the regional groundwater are discussed in the sections below.

Risks to commercial/industrial receptors (site workers) exposed to groundwater as a potable source at the HELSTF is not expected to occur because the regional groundwater beneath the HELSTF is generally poor quality, containing high TDS (well over 10,000 ppm). The current land use associated with the HELSTF is not expected to change. As a result, future use of HELSTF groundwater as a potable source for industrial purposes is considered very unlikely, but was considered as a conservative measure.

6.27.2 Risk Assessment Findings

The risks associated with exposure to groundwater are as follows:

- The total cumulative ELCR for future site workers using the regional groundwater as a potable water supply is 3×10^{-4}, as seen in Table E.20-HHRA-8 of Appendix E, which is greater than the acceptable target risk range of 1×10^{-6} to 1×10^{-4}. The total cumulative HI for site workers is 20, which is greater

than the benchmark of 1. The risk drivers for cancer risk are camphechlor and arsenic. The risk drivers for the non-cancer hazards were cobalt and lithium; and

- The total cumulative ELCR for a hypothetical age-adjusted future resident exposed to groundwater used as a potable water supply, as seen in Table E.20.HHRA-9 of Appendix E, is 2×10^{-3}, which is greater than the acceptable target risk range of 1×10^{-6} to 1×10^{-4}. The total cumulative HI for a hypothetical future child resident, as seen in Table E.20.HHRA-10 of Appendix E, is 118, which is well above the benchmark of 1. The risk drivers for cancer risk are arsenic and camphechlor. Cobalt and lithium are the risk drivers for non-cancer hazard.

The risks associated with exposure due to inhalation of vapor is as follows:

- The total cumulative ELCR for future site workers exposed to vapors migrating from regional groundwater into indoor air is 3×10^{-7}, which is less than the acceptable target risk range of 1×10^{-6} to 1×10^{-4}. The total cumulative HI for site workers is 0.0006, which is less than the benchmark of 1, indicating adverse non-cancer effects are unlikely to occur; and

- The total cumulative ELCR for a hypothetical age-adjusted future resident exposed to indoor air migrating from regional groundwater is 6×10^{-7}, which is less than the acceptable target risk range of 1×10^{-6} to 1×10^{-4}, as seen in Table E.20.HHRA-12 of Appendix E. The total cumulative HI for a hypothetical future child resident is 0.0002, which is less than the benchmark of 1, indicating adverse non-cancer effects are unlikely to occur.

6.27.3 Uncertainties in the HHRA

General uncertainties associated with HHRA are discussed in Appendix E, Section 2.2.5 (page 24). Site-specific uncertainties are discussed below.

Toxicity values were not available for sulfate. Therefore, exposure to sulfate could not be quantitatively evaluated. It is unlikely, however, that if toxicity values were available for sulfate, it would contribute significantly to the overall risk.

Exposure to lead was not quantitatively evaluated for groundwater exposures. Lead was detected once, at a concentration of 0.013 mg/L. This is less than the Federal

Action Level and, therefore, lead is not expected to contribute significantly to the overall risks.

7. Conclusions

The Phase III RFI for the HELSTF at WSMR has been completed. As part of the Phase III RFI, a comprehensive evaluation of all previously collected RFI data was conducted to determine whether releases occurred from the SWMUs and to evaluate associated risks to determine the need for corrective action. The comprehensive evaluation included:

- Preparing a Revised CSM;
- Conducting a Background Characterization Study;
- Conducting a comprehensive data evaluation to characterize subsurface conditions at each of the SWMUs; and
- Conducting comprehensive Human Health and Ecological Risk Assessments.

The revised CSM provides for a more current interpretation of conditions based upon additional evaluation of subsurface soil and groundwater data and technical information~~conditions~~. A water balance analysis was performed to estimate the flux of water infiltrating the vadose zone (historically~~previously~~ referred to at the site as perched water) and to estimate the potential for recharge and corresponding contaminant migration to the Regional Aquifer. A stable isotopes and mixing analysis was conducted to further~~better~~ characterize the infiltration ~~rate~~ and recharge ~~rate~~ from the vadose zone to the Regional Aquifer. Additionally, the revised CSM included a comprehensive geochemical evaluation to identify naturally occurring minerals that are associated with the geochemistry of subsurface sediments and water in the Tularosa Basin that extend beneath WSMR and the HELSTF. The revised CSM characterizes the environmental setting as follows:

- Groundwater recharge to the Tularosa Basin at the basin interior and near the site is negligible due to very low precipitation and high evapotranspiration rates.
- Water in the vadose zone is primarily the result of both historical discharges and ongoing leaks in the water distribution systems at the HELSTF. It is heterogeneously distributed both laterally and vertically. The water balance for the

HELSTF provides an explanation for the currently stable or decreasing water levels in the vadose zone. The net water flux is generally downward to the Regional Aquifer at a rate that is currently estimated at approximately ~~1 to 5~~2 gpm.

- The saturated portions of the vadose zone exhibit a complex localized pattern of limited connectivity that suggests that it is more appropriate to describe the vadose zone as a system with variable saturation rather than a system containing perched aquifers. The lack of lateral continuity in vadose zone water results in multi-directional transport under highly anisotropic conditions and commingling of dissolved contaminants in such a way that specific source identification is often difficult, and in some cases undetermined.~~The lack of lateral continuity in vadose zone water results in asymmetric transport and commingling of dissolved contaminants in such a way that specific source identification is often difficult, and in some cases undetermined.~~

- Due to the ~~highly~~ complex nature of flow paths in the vadose zone, the degree of connection observed between vadose zone water and groundwater in the Regional Aquifer varies with location across the HELSTF site and ultimately results in variable mass flux down to the Regional Aquifer.

- Natural geologic processes in the Tularosa Basin have resulted in the occurrence of soluble minerals that contain many inorganic ~~compounds~~constituents. Weathering of out-cropping rocks provides for the natural occurrence of metals(strontium, selenium, boron, fluoride, lithium, aluminum, barium, and vanadium) and other inorganic compounds (chloride, sulfate, and nitrate) for sediments accumulating in the basin. Scientific literature shows that simple dissolution of naturally occurring minerals causes many of these metals and inorganic compounds to exceed regulatory limits established for groundwater quality.

- Low redox conditions resulted from the biological degradation of organic material in the subsurface. Several naturally occurring elements at the HELSTF that include iron, manganese, arsenic, cobalt, copper, cadmium, antimony, and nickel become more soluble in water under low redox conditions when they are reduced themselves to more soluble forms or the minerals that contain them become less stable.

The Background Characterization Study was conducted to evaluate site-specific metal concentrations in support of the comprehensive geochemical evaluation described above. These results confirmed that several constituents identified within subsurface

soils beneath the HELSTF are naturally occurring. The results of this study, along with the comprehensive geochemical evaluation, were used to distinguish naturally occurring constituents from constituents that should be considered COPCs because they were released as wastes ~~(not naturally occurring constituents)~~ when evaluating the nature and extent of releases for the wastes managed at the SWMUs.

A comprehensive data evaluation was conducted to characterize the nature and extent of COPCs within subsurface soils and groundwater. As detailed in this report, soil and groundwater were evaluated using criteria established by the NMED and the EPA. Nature and extent determinations for soil were performed on a SWMU-by-SWMU basis. As explained by the CSM, groundwater pathways are more complex and required a site-wide approach for vadose zone and Regional Aquifer conditions. As part of this site-wide evaluation of groundwater, each COPC was evaluated with regard to its unique distribution in the vadose zone water and regional groundwater, and a conceptual model for the occurrence and distribution was used to identify its source and delineate its occurrence.

Risk assessments were conducted using data collected during the Phase I, Phase II, and Phase III RFI site investigations. The environmental data collected throughout the various phases of investigation were grouped by SWMU and medium of interest (e.g., soil and groundwater), and evaluated to produce risk assessment data sets. The risk assessments included HHRAs and ERAs. Site-specific HHRAs were conducted at each SWMU to evaluate the current and future potential risks to human health associated with constituents detected in surface and subsurface soil samples and in the vadose zone water underlying each SWMU. Site-specific ERAs were conducted at each SWMU to evaluate the potential current risks to ecological receptors associated with constituents detected in shallow soil conditions (i.e., in the upper 10 feet) at the HELSTF sites.

An HHRA was conducted to evaluate potential risks associated with human exposure to COPCs in groundwater from the Regional Aquifer. A site-wide approach was used for the HHRA of the Regional Aquifer because the aquifer is continuous and exhibits similar exposure potential across the HELSTF site. ~~Therefore, a holistic approach to the evaluation of potential risks in the Regional Aquifer is more appropriate.~~ In addition, the complexity of the hydrogeologic setting makes a SWMU-by-SWMU evaluation of the Regional Aquifer impracticable at the HELSTF. Therefore, a holistic approach to the evaluation of potential risks in the Regional Aquifer is more appropriate.

Based upon the RFI findings, the SWMUs have been grouped into one of three categories that include: SWMUs with no identified releases of COPCs; SWMUs with releases to soil only; and SWMUs with releases to both soil and groundwater.

SWMUs with no identified releases of COPCs include:

- SWMUs 23 and 24 – Hazardous Waste Tanks at HELSTF;
- SWMU 25 – Waste Accumulation Area;
- SWMU 26 – Vapor Recovery Unit at HELSTF;
- SWMU 27 – Sanitary Treatment Impoundment at HELSTF;
- SWMUs 31 and 32 – Chemical Waste Tank;
- SWMUs 33 and 34 – Fluorspar Tanks;
- SWMU 35 and 36 – Ethylene Glycol Tanks at HELSTF;
- SWMU 37 – Waste Oil Accumulation Area at Building 26121 at HELSTF;
- SWMU 145 – HELSTF Test Cell ~~4~~ Lagoons ~~Area~~;
- SWMU 146 –HELSTF STP Dry Pond;
- SWMU 147 – Decontamination Pad & Underground Holding Tank~~and UST~~;
- SWMUs 149,151, and 152 – Septic Systems; and~~.~~
- SWMU 150 – MAR Dump Site.

- SWMUs with releases of COPCs to soil only include:

- ~~SWMUs 31 and 32 – Chemical Waste Tanks;~~
- SWMUs 38 and 39 – ~~Construction~~ HELSTF Landfills;
- SWMU 141 – Equipment Storage Area; and~~,~~
- SWMU 148 – Former MAR Waste Stabilization Pond.

The soil conditions at the SWMUs listed above have been delineated.

SWMUs with releases to both soil and water include:

- SWMU 142 – HELSTF Cleaning Facility Sump;
- SWMU 143 – ~~Chromate~~HELSTF Storage Yard Chromium Spill Site;
- SWMU 144 – HELSTF LSTC Wastewater Discharge ~~Point~~Pond~~;~~ ; and
- ~~SWMU 148 – MAR Waste Stabilization Pond; and~~
- SWMU 154 – HELSTF Systemic Diesel Spill Site.

The soil conditions at the SWMUs listed above were delineated at or near the SWMU. Vadose zone water and regional groundwater were delineated on a site-wide basis.

~~The data used to evaluate SWMUs 27 through 30 (Sanitary Treatment System) do not indicate a release of hazardous constituents to soil. However, verification samples will be collected from beneath these SWMUs to evaluate the underlying conditions.~~

No site-specific investigations were conducted at AOC-N – Process Spills, AOC-Q – Laboratory Drains, and AOC-V – PRS. However, as further described within this report, there were no historical releases reported and historical operations posed very low risk for significant releases to have occurred. Furthermore, these AOCs were situated in very close proximity to other SWMUs that were investigated as part of the RFI. Additionally, the current RCRA permit list AOCs N and Q as "units with corrective action complete." Based on these conditions, no further action is recommended at the AOCs.

The results of the HHRA included the following:

- With the exception of SWMU 142, there were no unacceptable human health risks associated with current or future direct exposure to affected soils at any of the SWMUs. The direct exposure for a future residential scenario was determined to be above an acceptable target risk benchmark. The risk driver for this scenario was arsenic. Wastes containing arsenic were not managed at this SWMU. Arsenic is a naturally occurring metal that is attributed to low redox conditions beneath the Cleaning Facility.

- With the exception of SWMUs 142 and 154, the HHRAs show that affected soils do not pose a risk for current or future vapor intrusion. The HHRAs show that there are no current vapor intrusion risks for site workers at SWMUs 142 and 154. Future Site Worker and Future Resident vapor intrusion risks were identified for SWMU 142. Future Resident vapor intrusion risks were identified for SWMU 154. Because of the very low frequency of detection and limited spatial extent for the risk driver COPCs, in combination with the unlikely potential for future exposure (i.e., unlikely that the site will be redeveloped in the future), the concerns are low and additional evaluation is not necessary.

- DAF ~~1~~ exceedances in soils suggest the potential for cross-media contamination from soils to groundwater for some constituents. Based on the CSM and water balance, it is unlikely that constituents in soil that is currently dry could potentially migrate to groundwater in the future because evapotranspiration rates are sufficiently high to prevent infiltration of rainwater, and the infiltration from leaking water and sewer lines has decreased dramatically over time. However, as a conservative measure, a long-term monitoring plan will be developed to address the potential for soils to cause increased COPC concentrations in the Regional Aquifer.

Findings from the site-wide groundwater risk assessment indicated current risk to site workers and hypothetical future risk to adult and child residents associated with exposure to groundwater as a potable water source. The drivers for cancer risk identified by the HHRA are camphechlor and arsenic. The drivers for the non-cancer hazards identified by the HHRA are cobalt and lithium. Of these constituents, only arsenic occurs on a widespread basis in the regional groundwater. Camphechlor was only detected in one sample from the Regional Aquifer and its detection appears to have been a spurious detection, not associated with a release from any SWMU. Cobalt was only detected in 6 percent of the regional groundwater sample population and its distribution does not appear to be related to a release from any SWMU. Lithium and arsenic are naturally occurring minerals and their occurrence in the regional groundwater is not the direct result of a release from any SWMU.

The identified risks associated with exposure to the Regional Aquifer are hypothetical risks because the Regional Aquifer has poor quality with TDS concentrations consistently well above 10,000 ppm throughout the HELSTF area. There are no plans to use the Regional Aquifer at the HELSTF as a potable water source. Furthermore, the affected groundwater is fully contained within the confines of WSMR, which obtains its water from regional water wells outside the interior of the basin.

The results of the ERA include the following:

- Results of the SWMU-specific SLERAs and BERAs concluded that adverse effects are unlikely to occur for ecological receptors potentially exposed to constituents in soils under current or hypothetical future land use conditions.

Based upon the findings of the RFI and risk assessment, no further action is proposed for the following:

- SWMUs 23 and 24 – Hazardous Waste Tanks at HELSTF;
- SWMU 25 – Waste Accumulation Area;
- SWMU 26 – Vapor Recovery Unit~~;~~ at HELSTF;
- SWMU 27 – Sanitary Treatment Impoundment at HELSTF;
- SWMUs 31 and 32 – Chemical Waste Tanks;
- SWMUs 33 and 34 – Fluorspar Tanks;
- SWMUs 35 and 36 – Ethylene Glycol Tanks at HELSTF;
- SWMU 37 – Waste Oil Accumulation Area at Building 26121 at HELSTF;
- SWMUs 38 and 39 – ~~Construction~~ HELSTF Landfills;
- SWMU 141 – Equipment Storage Area;
- ~~SWMU 145 – Test Cell 4 Lagoon Area;~~
- ~~SWMU 144 – HELSTF LSTC Wastewater Discharge Point~~Pond~~;~~
- SWMU 145 – HELSTF Test Cell ~~4~~ Lagoon~~s Area~~;
- SWMU 146 – HELSTF STP Dry Pond;
- SWMU 147 – Decontamination Pad & Underground Holding Tank~~and UST~~;
- SWMU 148 – Former MAR Waste Stabilization Pond;
- SWMUs 149,151, and 152 – Septic Systems;

- SWMU 150 – MAR Dump Site;
- AOC-N – Process Spills at the HELSTF;
- AOC-Q – HELSTF Lab Drains; and
- AOC-V – HELSTF PRS.

Based upon results of the RFI and risk assessments, conditions identified at the following SWMUs will be addressed as part of a long-term groundwater monitoring program:

- SWMU 142 – HELSTF Cleaning Facility Sump;
- SWMU 143 – ~~Chromate~~HELSTF Storage Yard Chromium Spill Site~~; and~~;
- SWMU 144 – LSTC Wastewater Discharge Point; and
- SWMU 154 – HELSTF Systemic Diesel Spill.

Any warranted additional actions for SWMU~~s~~ 27 ~~through 30~~ (Sanitary Treatment System) will be determined following the proposed verification soil sampling.

As discussed in detail within this report, ~~evidence for~~ data demonstrates evidence that an off-site source(s) for TCE, 1,1-DCE, and chromium in the Regional Aquifer has been identified upgradient of the HELSTF area. The detections of these concentrations in the Regional Aquifer may be attributed to the off-site upgradient source. The evidence for the off-site source(s) is discussed in Section 6.23 (page 347) and is presented in detail within ~~appendices~~ Appendix I ~~to~~ of this report.

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Appendix A

Standard Operating Procedures

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Appendix B

Field Logs

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Appendix C

Supporting Information –
Conceptual Site Model

C-1 Historical Water Level Measurements

C-2 Water Balance Technical Memorandum

C-3 Stable Isotope Study

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Appendix D

Analytical Reports

D-1 Laboratory Reports

D-2 Water Analytical Summary Tables

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Appendix E

Human Health Risk Assessment
Report and Ecological Risk Report

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Appendix F

Background Characterization Report

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Appendix G

Site-Wide Soil Data Maps

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Appendix H

Site-Wide Groundwater Data Maps

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Appendix I

Technical Memorandum – Evidence for an Off-Site Source of TCE, 1,1-DCE, and Total Chromium in the Regional Aquifer Under the HELSTF